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SITE MANAGEMENT-RELATED CAUSES OF REWORK AND THE PERFORMANCE OF OIL AND GAS PROJECTS IN NIGERIA

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ABSTRACT

Purpose: One of the factors that often contribute significantly to cost and schedule overruns is rework. This study aimed at determining the influence of site management-related causes of rework on the performance of oil and gas construction projects.
Design/methodology/approach: A survey research design approach was adopted using stratified random sampling of 555 contractors and 395 consultants involved in the execution of oil and gas construction projects in South-South Geo-Political Zone of Nigeria. Data were collected through structured questionnaire and analysed using Mean Item Score, Spearman Rank Correlation test, Kruskal Wallis test and One Sample T-test.
Findings: Results of the study showed that there is agreement between contractors and consultants on the frequency of occurrence of site management-related causes of rework. Ineffective site leadership, poor communication, poor planning and allocation of resources, ineffective use of quality management practices and constructability problems are the five most occurring site management-related causes of rework in oil and gas construction projects. The result also indicated that these causes of rework have significant influence on time and cost performance of oil and gas construction projects. In addition, the result revealed that the occurrence and influence of site management-related causes of rework do not depend on project location.
Research limitations/implications: The study focused on site management-related causes of rework among other causes of rework in oil and gas construction projects. It also relied on the experiences and good judgement of the respondents to evaluate the frequency of occurrence and influence of these causes of rework on the cost and schedule performance of construction projects.
Practical implications: Quality management training for project site team, adequate time and resources availability for site verification prior to construction execution are recommended to enhance knowledge and awareness of quality control and reduce errors and omission which subsequently result in rework during construction.
Originality/value: The study concluded that site management-related causes of rework have significant influence on the cost and schedule performances of oil and gas projects and this influence does not depend on project location.

Keywords: Site management; influence; rework; oil and gas; performance; projects

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1. INTRODUCTION

The construction industry in both developed and developing countries has been widely acknowledged as an important sector that contributes significantly to the economic growth of a nation. The industry which is project based is focused on the timely delivery of construction projects. However, due to significant amount of rework attributed to ineffective project management practices, project activities are extended beyond their scheduled deadline (Love and Edwards, 2004). Because of this, the industry has been criticized extensively for poor performance (Enshassi, Mohamed and Abushaban 2007). Previous studies (Alwi, Hampson and Mohammed, 2002; Josephson, Larson and Li, 2002; Oyewobi and Ogunsemi, 2010) recognised rework as a non-value adding activity, while Robin McDonald and LEED (2013) viewed rework as work that is made to conform to the original requirements by completion or correction at least one extra time due to non-conformance with requirements.

The need for rework normally occurs when construction deliverables fails to meet contractual requirement. Consequently, the deliverables are reworked in accordance with the contractual requirements. For this reason, Love and Smith (2003) opined that there is need to understand the root cause associated with rework, the reason why rework exist and the conditions that stimulate occurrence of rework within construction process. In response to this call, Love and Edwards (2004) reported that, poor project management practices contribute to the occurrence of rework in construction projects, these practices include those related to client, design team and site management. In addition, Palaneeswaran, Kumaraswamy, Ng and Love (2005) reported that site-management related factors are responsible for rework in construction project. These underlying causes among others are site specific constructability issues, poor planning and allocation of resource to construction activity, inadequate training of resources, setting-out errors and failure to provide protection for constructed works (Love, 2002).

To meet up with construction datelines, project activities in Oil and Gas are usually scheduled to run concurrently. As a result, errors and omission may likely occur due to poor coordination of interrelated activities thus resulting in rework. Since rework is performing a task more than once, it can occur at different stages throughout the project life cycle, either during design, fabrication, construction or installation phase. At the construction and installation stage, Love, Edwards Irani and Goh, (2011) reported that poor project management; poor scope management, unrealistic schedule and non-adherence to quality system are causes of rework in offshore projects. Consequently, when rework occurs in oil and gas construction projects, there is a significant influence on time and cost performance (Love, Edwards Irani and Goh, 2011). This therefore infers that the increase in time and cost overrun is correlated with the magnitude of rework cases in oil and gas construction projects.

Although site-management related factors featured prominently among those factors identified as causes of rework in construction projects, none of these studies considered the frequency of occurrence and influence of site-management causes of rework on time and cost performance across geographical demarcations by comparing the views of consultants and contractors – important project team members who are directly involved in construction execution. The south-south zone of Nigeria which comprises of six geographical states namely: Akwa Ibom, Bayelsa, Cross River, Delta, Edo and Rivers were the areas selected for this study. The choice of this area was influenced by the reported

increase in its volume of construction activities driven by increasing energy demand. Consequently, determining the influence of site-management related causes of rework on project performance would be pertinent to the successful delivery of construction projects in this zone, especially given that no such studies have been conducted in this region. In view of this, this study sought to determine whether the influence of site-management related causes of rework on cost and time performance varies across the geographical states in the south-south geo-political zone of Nigeria. An understanding of the influence of site management-related causes of rework on the performance of oil and gas projects across these geographical states would enable construction managers to better manage and execute oil and gas projects successfully across geographical locations. Therefore, comparing the perceptions of consultants and contractors would assist in emphasising site-management related causes of rework that significantly affect project performance and, on the other hand, help to present a holistic approach to addressing the causes of rework in oil and gas construction project in South-South, Nigeria.

1.1. Objectives of the study

The objectives of the study are to:

i. determine contractors and consultants' perceptions of the frequency of occurrence of site management-related causes of rework in oil and gas construction projects,
ii. evaluate the influence of site management-related causes of rework on project performance in terms of cost and time based on the perceptions of selected project team members, and
iii. assess the influence of project location on the frequency of occurrence of site management-related causes of rework and its impact on project performance as perceived by the selected project team members.

1.2. Research hypotheses

To achieve the objectives of the study, five hypotheses were formulated which state that:

H_1: There is no significant correlation between consultants' and contractors' perceptions of the frequency of occurrence of site management-related causes of rework in oil and gas construction projects,

H_2: The frequency of occurrence of site management-related causes of rework in oil and gas construction projects do not vary significantly across the states in South-South Geo-Political Zone of Nigeria.

H_3: There is no significant correlation between consultants' and contractors' perceptions of the influence of site management-related causes of rework on cost and time performance of oil and gas construction projects,

H_4: The influence of site management-related causes of rework on time and cost performance is not significant,

H_5: The influence of site management-related causes of rework on cost and time performance of oil and gas construction projects do not vary significantly across the states in South-South Geo-Political Zone of Nigeria.

2. REVIEW OF RELATED LITERATURE

2.1. Site management-related causes of rework

Majority of causes of rework arises due to lack of communication and supervision (Clough, Sears Sear, Segner and Rounds, 2015). Several researchers (Love and Edwards, 2004; Oyewobi and Ogunsemi, 2010) have identified site management-related factors contributing to rework in construction projects. According to Love and Edwards (2004), poor site leadership and ineffective communication among project team members result in rework. In line with this finding, Love, Edwards, Irani and Walker (2009) emphasized that the problems with leadership relate to ineffective management of the project team, poor communications, lack of safety, and lack of quality assurance or controls. Some of the errors and issues arising during construction can be remedied with better communication and more information sharing. Clough *et al.* (2015) suggests that project specifications, written guidelines and method statement on project work must be clearly communicated to and accessible by the workforce. In addition to this, Love, Edwards, Irani and Walker (2009) revealed that the underlying causes of ineffective site leadership are the decisions undertaken by top management which consequently lead to the adoption of inappropriate construction practices and processes.

Inadequate coordination of construction activities and resources has been noted as another site management related factor causing rework in construction projects. According to Palaneeswaran, Kumaraswamy, Ng and Love (2005), inadequate planning and coordination of resources are factors that contribute to the occurrence of rework in construction projects. A study by Josephson, Larsson and Li (2002) reported that changes due to improper planning contribute significantly to rework cost. As the workforce effects the changes and errors resulting from improper planning, the indirect consequence is stress and fatigue on the workforce (Mastenbroek, 2010). On the other hand, when the project is behind schedule or the need for rework arises, overtime is typically utilized to bring back the project on track. Such excessive overtime can cause fatigue to workers, reduces productivity which result in poor quality of work and consequently lead to rework. For this reason, emphasis must be laid on adequate planning to avoid unnecessary rework.

Poor quality management implementation in construction site has been a major cause of concern to the industry because of its contribution to rework (Jaafari, 1996). Alwi, Hampson, and Mohamed (2002) argued that quality management principles and tools are not strongly embedded in conventional construction management practice, although, the construction industry places emphasis on quality management systems implementation through the advancement of International Organization for Standardization (ISO) certification for construction contractors, This limitation results in substandard services and products, which inevitably produces rework (Love, Edwards, Irani and Walker, 2009). However, the implementation of an effective quality assurance system in a construction project leads to rework reduction and improvement in project performance (love and Edwards, 2004),

According to Fayek, Dissanayake, and Campero (2003), unrealistic construction schedule, non-compliance with specifications, use of wrong materials, untimely deliveries or lack of materials at the job site are factors that can potentially create rework in construction projects. A project with an unrealistic schedule may pose excessive schedule pressure on construction team and would inadvertently lead to working out of sequence, creating work defects and cutting corners, which may consequently lead to rework (Nepal,

Park and Son, 2006). A study by Love, Edwards and Irani, (2008) further revealed that schedule constraints and client pressure often lead to lack of attention by management resulting in poor quality of work which results in rework and poor performance.

Rework in construction project also originates from parties in the construction projects. According to Arain and Low (2006), the key project players contributing to rework in construction projects are client, consultant, and contractor. Even though contractor and consultant often plays different roles in the delivery of construction projects, Hwang, Thomas, Hass and Carlos (2009) stated that, they have significant influence on rework occurrence. The authors also reported that changes requested by client were the second largest contributor to the direct cost of field rework in construction projects. Furthermore, a study by Love and Edwards (2004) also considered client, contractor and design team as parties contributing to rework in construction. In view of this, consultants and contractors are considered to be an important member of the project team who are knowledgeable with the causes and impact of rework on oil and gas projects. Therefore, comparing consultants and contractor's perception of the occurrence and influence of site management-related causes of rework on project performance will provide a more holistic view of the frequency of occurrence and influence of site management-related causes of rework on project cost and time performance.

2.2. Influence of rework on project performance

Cost and time overrun are metrics frequently used to measure project performance within the construction industry. Studies have shown that rework contributes significantly to time and cost overrun of construction project (Love and Edwards, 2004, Hwang, Thomas, Hass and Carlos, 2009; Love and Sing, 2013). The varying interpretations and definitions of rework have led to lack of uniformity in rework data collation and quantification. Therefore, understanding the critical factors that causes rework has been posited to be necessary for the enhancement of project performance. Reflecting this perspective, Jergeas (2009) reported that there are undue cost overruns, delays and losses of productivity associated with the delivery of major capital construction projects everywhere in the world. Jergeas's study found that researchers and practitioners have identified poor management practices that lead to poor performance, such as scope changes, design errors and omissions, lack of proper planning and scheduling and improper management of tools, equipment, materials and labour, among many other factors.

In addition to several factors contributing to cost overrun mentioned in Jergeas (2009), Palaneeswaran (2006) highlighted that the cost and time overrun of projects attributed to rework were as a result of errors in design, omission during construction, failures of constructed part, changes initiated by client or his representative, poor communication and poor coordination. According to Love and Edwards (2004), rework in Australian construction projects consumes up to 6.5% of the total project cost and contributing significantly to schedule delay. Similarly, Rhodes and Smallwood (2003) stated that rework is capable of increasing the cost of construction project cost in South Africa by 13%. In Nigeria, Oyewobi, Oke, Ganiyu, Shittu, Isa, and Nwokobia (2011) reported that time overrun and cost overrun on building project were 37.26% and 9.88% respectively. They also reported that the cost of rework was 3.47% of the contract value. In the same study, cost of rework for new building and refurbished building in Nigeria was 5.06% and 3.23% of the contract value respectively. These findings show that the incidence of rework have impact on cost and time performance on construction projects.

Oil and gas projects also suffer from rework. The impact of rework on the performance of oil and gas project has been reported in previous studies, most notably, Love, Edward, Irani and Goh (2011) revealed that rework significantly impacts the performance of oil and gas project. The authors reported that rework costs in offshore hydrocarbon projects were estimated to range from 3% to 25% of capital expenditure. For offshore projects, Love and Edwards (2013) reported that rework arises due to errors and omissions, and this can significantly contribute to project cost and cause schedule overruns. The authors affirmed that these additional and unnecessary costs can account for 25% of capital expenditure for offshore platform projects. Hwang and Leong (2013) also noted that when construction work is subcontracted, and coordination between various activities is not effective, deviations from the requirements may result, leading to rework that can trigger cost and schedule overruns.

3. METHODOLOGY

Exploratory survey research design involving the use of structured questionnaire was employed in this study. The population of the study comprises contractors and consultants involved in the execution of oil and gas construction projects. A total of 667 contractors and 475 consultants were identified through pilot study and this served as the study population frame. The sample sizes for the two groups of respondents across the six states in South-South Geo-Political Zone of Nigeria were determined using Taro Yamane formula for finite population which states:

$$n = \frac{N}{1+N(e)^2} \qquad \text{.....(1)}$$

Where n = Sample size; N = Finite Population; e = Level of significance (0.05) and 1 = Unity (Udofia, 2011).

Table 1 shows the sampling frames and sample sizes for the two groups of respondents in the study area. To account for void questionnaire and non-response from respondents, a total of 950 copies of questionnaire comprising 555 contractors and 395 consultants obtained through simple proportion were administered on the study population randomly across the states in the study area. Table 2 shows the distributions of questionnaire for the groups of respondents in the study area and the valid questionnaire used for data analysis.

Table 1: Sample frames and sample sizes of contractors and consultants in the study area

Sampling Frame/Sample Size	Groups of Respondents	Location of Study						
		AKS	BYS	CRS	EDS	DES	RVS	Total
Sampling Frame	Contractors	193	152	32	71	85	134	667
	Consultants	116	57	85	45	134	38	475
Sample Size	Contractors	130	110	30	60	70	100	500
	Consultants	90	50	70	40	100	35	385

**AKS=Akwa Ibom State, BYS=Bayelsa State, CRS=Cross River State, EDS=Edo State, DES=Delta State, RVS=Rivers State*

Structured questionnaires were used to collect data on the frequency of occurrence and relative influence of sixteen identified site management-related causes of rework from two selected project team members who constitute the respondents for the study. The frequency of occurrence of the site management-related causes of rework and its influence on time and cost performance was measured on a five-point Likert-scale namely: nil, low, moderate, high and very high. Weights were assigned to the scale as follows: nil=1, low=2, moderate=3, high=4 and very high=5. Out of 950 copies of questionnaire administered on the sampled study population through stratified random sampling techniques, 902 correctly completed questionnaire comprising 510 contractors and 392 consultants were used for the analysis.

Table 2: Questionnaire distributions for respondents in the study area

Groups of Respondents	Location of Study						Total Questionnaire Distributed	Total Valid Questionnaire Used for Analysis
	AKS	BYS	CRS	EDS	DES	RVS		
Contractors	144	122	33	67	78	111	555	510
Consultants	92	51	72	41	103	36	395	392

Data collected were analysed using Statistical package for social science (SPSS) version 24. The frequency of occurrence of site management-related causes of rework and its influence on time and cost performance of oil and gas construction projects were analysed using Mean Item Score (MIS). Spearman Rank Correlation was used to test the agreement of contractors and consultants on the frequency of occurrence and influence of site management-related causes of rework on cost and time performance. Kruskal-Wallis H test was used to evaluate variation in frequency of occurrence and influence of site management-related causes of rework on cost and time performance across the six states that constitute the study area as perceived by contractors and consultants. The decision rule for testing hypothesis is that, if P-value is less than or equal to α at 5% level of significance, then the null hypothesis is rejected in favour of the alternate hypothesis. The decision rule used in this study is stated below: If $P \leq 0.05$, reject H_0 otherwise, If $P > 0.05$, then fail to reject H_0.

Likert scale data has been considered as ordinal scale data, however, previous studies have adopted parametric statistical methods such as the t-test for analysing the data (Hwang, Zhao and Goh, 2014; Zhao, Hwang Shan and Tan, 2016). Although, Zumbo and Zimmerman (1993) believed that there is no basis to analyse parametric statistics using ordinal level data when the assumptions are not met. Norman (2010) argued that parametric statistics can be used to analyse Likert data with unequal variances and non-normal distributions, without fear of coming to wrong conclusions. Therefore, this study adopts one sample t-test using a hypothesised mean ($\mu = 2.5$) to test the significance of the influence of site management-related causes of rework on cost and time performance in line with related previous studies (Adamu, Dzasu, Haruna and Bala, 2011; Durdyev and Mbachu, 2011). The decision rule is that if the Mean Score of all site management-related factors are equal or greater than the hypothesised MS then the factors are considered to have significant influence on cost and time performance (i.e. p-value ≤ 0.05). Otherwise it will be insignificant as will be indicated by p-value that is greater than the critical value of 0.05 (i.e. p-value >0.05).

Mean Item Score was obtained by dividing the total score by the number of the respondent for each of the site management-related causes of rework. The average of the (MIS) was used to determine the most frequently occurring site management-related causes of rework. Mean Item Scores equal to or above the average (MIS) was considered the most frequently occurring site management-related causes of rework. Similarly, the average of the (MIS) was used to determine the site management-related causes of rework having significant influence on cost and time performance. Mean Item Scores equal to or above the average (MIS) was regarded as significant.

4. PRESENTATION OF RESULTS

Data obtained on a five-point Likert scale from the structured questionnaire were collated and analysed using appropriate statistical tools as described in the methodology. The results of data analysis carried out to achieve the objectives of the study are presented below.

4.1. Contractors and consultants' perceptions of the frequency of occurrence of site management-related causes of rework in oil and gas construction projects

The first objective of the study is to determine consultants and contractor's perceptions of the frequency of occurrence of site management-related causes of rework in oil and gas projects. Data collected on the perceptions of consultants and contractors on the frequency of occurrence of each of the sixteen site management-related causes of rework in oil and gas projects were analysed to derive their Mean Item Score and ranks. Results are presented in Table 3.

The result in Table 3 indicates that consultants and contractors considered eight (8) site management-related factors having (MIS) ≥ 2.93 as most frequently occurring site management-related causes of rework and the remaining eight (8) site management-related factors as least occurring site management-related causes of rework in oil and gas construction projects.

4.2. Test of correlation between contractors' and consultants' perceptions of the frequency of occurrence of site management-related causes of rework

To test the first hypothesis of the study, contractors and consultants' perception of the frequency of occurrence of site management-related causes of rework in oil and gas projects were compared for agreement using Spearman's Test of correlation. Result of the test of hypothesis is presented in Table 4.

The result in Table 4 shows high correlations between the perceptions of consultants and contractors on the frequency of occurrence of site management-related causes of rework in oil and gas construction projects ($r< 0.953$). Additionally, the *p*-value which is less than the critical value ($p< 0.001$) further confirms that the correlation is significant. Therefore, the first hypotheses which stated that there is no significant correlation between consultants' and contractors' perceptions of the frequency of occurrence of site

management-related causes of rework in oil and gas construction projects is rejected. The implication of this result is that both contractors and consultants agree and have similar views on the frequency of occurrence of each of the site management-related causes of rework in oil and gas construction projects in Nigeria.

Table 3: Consultants and contractors' perceptions of the frequency of occurrence of site management-related causes of rework in oil and gas construction projects

Site management-related causes of rework	Consultant (N=392)			Contractor (N=510)		
	Sum	Mean Item Score	Rank	Sum	Mean Item Score	Rank
Ineffective site leadership	1508	3.85	1*	1977	3.88	1*
Poor communication	1426	3.64	2*	1833	3.59	2*
Poor planning and allocation of construction resources	1347	3.44	3*	1789	3.51	3*
Ineffective use of quality management practices	1208	3.08	6*	1645	3.22	4*
Constructability problem	1267	3.23	4*	1629	3.19	5*
Unrealistic schedule	1202	3.07	7*	1607	3.15	6*
Setting-out errors	1185	3.02	8*	1580	3.10	7*
Non-compliance with specification	1216	3.10	5*	1520	2.98	8*
Failure to provide protection to constructed works	1074	2.74	11	1415	2.78	9
Unforeseen site condition	1050	2.68	12	1413	2.77	10
Unclear instructions to workers	1132	2.89	9	1405	2.76	11
Excessive overtime	1096	2.80	10	1341	2.63	12
Wrong construction methodology	987	2.52	13	1317	2.58	13
Use of damaged or obsolete material	961	2.45	14	1219	2.39	14
Ineffective use of information technology	925	2.36	15	1144	2.24	15
Lack of safety	797	2.03	16	1065	2.09	16
Average Mean Item Score		2.93			2.93	

* = *Most Frequently Occurring*

Table 4: Spearman test of correlation between contractors and consultant's perception

Parameter Correlated	N	r	*p*-value	decision
Contractors' and consultant's perception of the frequency of occurrence of site management-related cause of rework on oil and gas projects	16	0.953	0.000	Reject

r = correlation coefficient

4.3. Selected team members' perceptions of the frequency of occurrence of site management-related causes of rework in oil and gas construction projects

Having concluded that there is agreement between consultants and contractors' perception of the frequency of occurrence of site management-related causes of rework in oil and gas construction projects, data collected from the two selected project team members were combined and analysed to form selected team members' perceptions of the frequency of occurrence of site management-related causes of rework in oil and gas projects. Results are presented in Table 5.

Table 5: Selected team members' perceptions of the frequency of occurrence of site management-related causes of rework in oil and gas construction projects

Site Management-related causes of rework	Sum	Mean Score	Item Rank
Ineffective site leadership	3482	3.86	1*
Poor communication	3256	3.61	2*
Poor planning and allocation of construction resources	3139	3.48	3*
Ineffective use of quality management practices	2895	3.21	4*
Constructability problem	2850	3.16	5*
Unrealistic schedule	2814	3.12	6*
Setting-out errors	2769	3.07	7*
Non-compliance with specification	2733	3.03	8*
Failure to provide protection to constructed works	2535	2.81	9
Unforeseen site condition	2490	2.76	10
Unclear instructions to workers	2462	2.73	11
Excessive overtime	2435	2.70	12
Wrong construction methodology	2309	2.56	13
Use of damaged or obsolete material	2183	2.42	14
Ineffective use of information technology	2066	2.29	15
Lack of safety	1858	2.06	16
Average Mean Item Score		2.93	

*N = 902; * = Most Frequently Occurring*

The result in Table 5 indicates that out of eight (8) site management-related factors having (MIS) $\geq$ 2.93, 'ineffective site leadership', 'poor communication', 'poor planning and allocation or resources', 'ineffective use of quality management system' and 'constructability problems' are the five most frequently occurring site management-related causes of rework in oil and gas construction projects.

4.4. Test of variation in the frequency of occurrence of site management-related causes of rework across states in south-south, Nigeria

Having determined the combined views of the two project team members on the frequency of occurrence of site management-related causes of rework in oil and gas construction projects, the variation in frequency of occurrence of site management-related causes of rework across states in South-South as perceived by contractors and consultants was assessed using Kruskal-Wallis test. The result is presented in Table 6.

The result of Kruskal-Wallis H test in Table 6 shows that the variation in frequency of occurrence of site management-related causes of rework across the States in South-South, Nigeria as perceived by consultants and contractor is not significant, $X^2(5) = 1.251$, $p = 0.940$ and $X^2(5) = 3.184$, $p = 0.672$ respectively. Arising from this, the test fails to reject the second hypotheses which states that, the frequency of occurrence of site management-related causes of rework in oil and gas construction projects do not vary significantly across the states in South-South Geo-Political Zone of Nigeria. The implication of this result is that

the frequency of occurrence of site management-related causes of rework is the same across all the states.

Table 6: Kruskal-Wallis (H) test of variation in the frequency of occurrence of site management-related causes of rework across states in south-south, Nigeria

Location of Study	N	Frequency of Occurrence as perceived by consultants				Frequency of Occurrence as perceived by contractors			
		Mean Rank	Test Statistic	*p*-value	Decision	Mean Rank	Test Statistic	*p*-value	Decision
AKS	16	51.88				49.69			
BYS	16	49.91				48.06			
CRS	16	52.47	1.251	0.940	Accept	52.47	3.184	0.672	Accept
DES	16	44.06				56.22			
EDO	16	47.47				42.50			
RVS	16	45.22				42.06			
Total	96								

**AKS=Akwa Ibom State, BYS=Bayelsa State, CRS=Cross River State, EDS=Edo State, DES=Delta State, RVS=Rivers State, N=Number of Factors*

4.5. Contractors and consultants' perceptions of the influence of site management-related causes of rework on performance of oil and gas construction projects

The second objective of the study is to evaluate the influence of site management-related causes of rework on performance construction projects in terms of cost and time. Data collected on the perceptions of consultants and contractors on the influence of twenty-two site management-related factors on project time and cost were analysed to derive their Mean Item Score and ranks. Results are presented in Table 7.

The result in Table 7 indicates that consultants and contractors considered eight (8) site management-related factors having (MIS) $\geq$ 2.95 and (MIS) $\geq$ 2.97 respectively to have significant influence on project time performance. Similarly, consultants and contractors considered eight (8) site management-related factors having (MIS) $\geq$ 3.05 and (MIS) $\geq$ 3.07 respectively to have significant influence on project cost performance.

4.6. Test of correlation between contractors' and consultants' perceptions of the influence of site management-related causes of rework on project performance

To test the third hypothesis of the study, contractors and consultants' perception of the influence of site management-related causes of rework on project time and cost performance were compared for agreement using Spearman's Test of correlation. Result of the test of hypothesis is presented in Table 8.

The result shows high correlation between the perception of consultants and contractors on the influence of site management-related causes of rework on project time and cost performance ($r< 0.989$) and ($r< 0.986$) respectively. Addionally, the *p*-value which is less than the critical value ($p< 0.001$) further confirms that the correlations are significant. Therefore, the null hypothesis which stated that, there is no significant correlation between consultants' and contractors' perceptions of the influence of site management-related causes of rework on cost and time performance of oil and gas construction projects is

rejected. This result implies that both contractors and consultants agree and have similar views on the influence of site management-related causes of rework on time and cost performance of oil and gas projects in Nigeria.

Table 7: Consultants and contractors' perceptions of the influence of site management-related causes of rework on project time and cost performance

	Time Performance				Cost Performance			
	Consultant (N=392)		Contractor (N=510)		Consultant (N=392)		Contractor (N=510)	
Site management-related causes of rework	MIS	Rank	MIS	Rank	MIS	Rank	MIS	Rank
Ineffective site leadership	3.82	1*	3.82	1*	3.71	2*	3.91	1*
Poor communication	3.54	2*	3.56	2*	3.82	1*	3.82	2*
Poor planning and allocation of construction resources	3.49	3*	3.50	4*	3.68	3*	3.67	3*
Ineffective use of quality management practices	3.44	4*	3.51	3*	3.58	4*	3.60	4*
Constructability problem	3.28	5*	3.24	5*	3.53	5*	3.57	5*
Unrealistic schedule	3.08	7*	3.22	6*	3.43	6*	3.46	6*
Setting-out errors	3.05	8*	3.15	7*	3.28	7*	3.24	7*
Non-compliance with specification	3.13	6*	3.07	8*	3.02	8*	3.07	8*
Failure to provide protection to constructed works	2.74	9	2.78	10	2.65	13	2.78	11
Unforeseen site condition	2.68	10	2.77	11	2.74	10	2.78	9
Unclear instructions to workers	2.65	12	2.78	9	2.73	11	2.74	10
Excessive overtime	2.66	11	2.70	12	2.72	12	2.73	12
Wrong construction methodology	2.49	13	2.45	13	2.80	9	2.63	13
Use of damaged or obsolete material	2.45	14	2.39	14	2.49	14	2.45	14
Ineffective use of information technology	2.35	16	2.30	15	2.45	15	2.39	15
Lack of safety	2.36	15	2.24	16	2.13	16	2.30	16
Average (MIS)	2.95		2.97		3.05		3.07	

* *Significant Influence*

Table 8: Spearman test of correlation between contractors and consultant's perception of the influence of site management-related causes of rework on project performance

Parameter Correlated	N	r	*p*-value	Decision
Time Performance	16	0.989	0.000	Reject
Cost Performance	16	0.986	0.000	Reject

r = correlation coefficient; N= Number of factors

4.7. Selected team members' perceptions of the influence of site management-related causes of rework on cost and time performance of oil and gas projects

Having established that consultants and contractors' perception of the influence of site management-related causes of rework on time and cost performance of oil and gas construction projects is the same, the data collected from the two selected groups of project team members were combined and analysed to determine the perception of selected project

team members on the influence of site management-related causes of rework on time and cost performance in the study area. Results are presented in Table 9.

The result in Table 9 indicates that out of eight (8) site management-related factors having (MIS) ≥ 2.96 and (MIS) ≥ 3.06 ,'ineffective site leadership', 'poor communication', 'poor planning and allocation or resources', 'ineffective use of quality management system' and 'constructability problems' are the top five site management-related factors having influence on time and cost performance of oil and gas construction projects. Ranks of influence of other site management-related causes of rework on cost and time performance of oil and gas construction projects according to selected team members' perceptions are shown in Table 9.

Table 9: Selected Team Member's perceptions of the influence of site management-related causes of rework on cost and time performance.

	Time Performance		Cost Performance	
Site management-related causes of rework	MIS	Rank	MIS	Rank
Ineffective site leadership	3.82	1*	3.83	1*
Poor communication	3.55	2*	3.82	2*
Poor planning and allocation of construction resources	3.50	3*	3.68	3*
Ineffective use of quality management practices	3.48	4*	3.59	4*
Constructability problem	3.26	5*	3.56	5*
Unrealistic schedule	3.16	6*	3.45	6*
Setting-out errors	3.11	7*	3.26	7*
Non-compliance with specification	3.10	8*	3.05	8*
Failure to provide protection to constructed works	2.73	10	2.76	9
Unforeseen site condition	2.73	11	2.74	10
Unclear instructions to workers	2.76	9	2.73	11
Excessive overtime	2.69	12	2.72	12
Wrong construction methodology	2.47	13	2.70	13
Use of damaged or obsolete material	2.42	14	2.47	14
Ineffective use of information technology	2.32	15	2.42	15
Lack of safety	2.29	16	2.23	16
Average MIS	2.96		3.06	

*N = 902 * Significant Influence*

4.8. T-test of significance of the influence of site management-related causes of rework on cost and time performance

The influence of sixteen site management-related causes of rework on time and cost performance was tested using One-Sample t-test. Results are presented in Table 10. The positive mean differences in Table 10 shows that the average MIS of the perceptions of selected project team members' influence of site management-related factors on time and cost performance is greater than the hypothesized mean value of 2.5 respectively. Furthermore, *p*-values (0.002 and 0.001) obtained from the analysis are less than the critical value of 0.05 ($p < 0.05$). This also confirms that the difference between the average MIS and the hypothesised mean is significant. Therefore, the fouth hypothesis which stated that, the influence of site management-related causes of rework on time and cost performance is

not significant is rejected. The result implies that site management-related causes of rework have significant influence on project time and cost performance of oil and gas construction projects.

Table 10: Results of one sample t-test of the influence of site management-related causes of rework on cost and time performance

Test value = 2.5					95% confidence interval of the difference		
	Performance Variables	N	Mean	Mean Diff	Lower	Upper	*p*-Value
Influence of site management-related causes of rework	Time	16	2.96	0.462	0.207	0.717	0.002
	Cost	16	3.06	0.563	0.279	0.848	0.001

N = numbers of factors

4.9. Test of variation in the influence of site management-related factors on time and cost performance across the states in south-south, Nigeria

The influence of site management-related causes of rework on time and cost performance across the states in South-South region as perceived by contractors and consultants were assessed using Kruskal-Wallis test. The result is presented in Table 11.

Table 11: Kruskal-Wallis (H) test of variation in the influence of site management-related causes of rework on cost and time performance across states in south-south, Nigeria

Respondents	Location of Study	N	Time Performance				Cost performance			
			Mean Rank	Test Statistic	*p*-value	Decision	Mean Rank	Test Statistic	*p*-value	Decision
Contractors	AKS	16	50.59				50.97			
	BYS	16	47.34				46.84			
	CRS	16	51.66	1.547	0.990	Accept	54.31	1.210	0.944	Accept
	DES	16	48.91				46.09			
	EDO	16	46.78				45.56			
	RVS	16	45.72				47.22			
Consultants	AKS	16	50.59				40.81			
	BYS	16	47.34				45.38			
	CRS	16	51.66	2.733	0.741	Accept	52.56	2.170	0.825	Accept
	DES	16	48.91				52.97			
	EDO	16	46.78				48.09			
	RVS	16	45.72				41.19			

**AKS=Akwa Ibom State, BYS=Bayelsa State, CRS=Cross River State, EDS=Edo State, DES=Delta State, RVS=Rivers State, N=Number of Factors*

The result of Kruskal-Wallis H test in Table 11 shows that the difference in influence of site management-related causes of rework on time and cost performance as perceived by contractors and consultants is not significant, X^2 (5) =1.547, p=0.990; X^2 (5) =1.210, p=0.944; X^2 (5) =2.733, p=0.741 and X^2 (5) =2.170, p=0.825 respectively. Arising from this, the test fails to reject the fifth hypothesis which stated that, the influence of site management-related causes of rework on cost and time performance of oil and gas

construction projects do not vary significantly across the states in South-South Geo-Political Zone of Nigeria.

5. DISCUSSION OF RESULTS

The results of this study revealed that there is agreement between contractors' and consultants' perceptions of the frequency of occurrence of site management-related causes of rework in the study area. Implying that contractors and consultants agree on the site management causes of rework that frequently or rarely occurs in oil and gas construction projects. This result agrees with Love and Edwards (2004) who reported that the perceptions of respondents on the occurrence of rework causes in construction projects are the same. Their agreement regarding the occurrence of rework pertaining to site management will guide construction professional towards effective rework mitigation at construction site. Consequently, the combination of their opinion in this study reveals that "ineffective site leadership", "poor communication", "poor planning and allocation of resources", "ineffective use of quality management practices" and "constructability problems" are the five most frequently occurring site management-related causes of rework in oil and gas construction projects. On the contrary, Love and Smith (2003) reported variations in the perceptions of contractors, consultants and project managers regarding the occurrence of 'poor planning and allocation of resources' as factor contributing to rework in construction projects. Along the same line, Love and Edwards (2004) noted that, although, there is variation in the perceptions of the three groups of respondents, their combined views revealed that poor planning and allocation of resources ranked first and was thus considered the most occurring causes of rework.

Furthermore, this study indicated that contractors' and consultants' perception of the influence of site management-related causes of rework on project performance is the same. This implies that the selected project team members who constitute respondents for the study agrees on the site management-related causes of rework that influence cost and time performance of oil and gas projects in Nigeria. This result corroborates findings from previous studies (Palaneeswaran, 2006; Wasfy, 2010; Simpeh, 2012 and Zaiter, 2014) where contractors', consultant' and owner' perceptions of the effect of site management-related factors on project performance of building projects was reported to be the same. The result of this study has also shown that site management-related causes of rework that frequently occurs in Oil and Gas construction project also have significant influence on time and cost performance. Based on this, the selected project team members were seen to consider "ineffective site leadership", "poor communication", "poor planning and allocation of resources", "ineffective use of quality management practices" and "constructability problems" as the five most significant site management-related causes of rework having influence on cost and time performance of oil and gas projects. This result corroborate the findings in Love, Edwards, Irani and Walker (2009) who reported that rework occurrence in heavy industrial projects as perceived by contractors have significant impact on cost performance.

When a construction project is not performing as expected, it is the site leadership team who is questioned because they have greater responsibility to ensure that the project delivers benefit to the customer. According to Palaneeswaran, Love, Kumaraswamy, and Ng (2008), poor site management which stems out from ineffective site leadership contributes significantly to rework occurrence in construction projects. In line with Palaneeswaran *et al*., (2008), avoiding defects and non-conformance in building and

construction projects depends on the effectiveness of site leadership (Jarkas, Kadri and Younes, 2012). In the same vein, Oyewobi, Abiola-Falemu and Ibironke (2014) reported that ineffective site management may result in improper separation of work or line of authorities which might lead to poor performance. For this reason, Zaiter (2014) and Mahamid (2016) reported that poor site management have severe impact on project performance and they ranked this factor first and fourth respectively. In line with this agreement, "ineffective site leadership" ranked first among other site management-related causes of rework having influence on project performance in this study.

According to Fayek, Dissanayake, and Campero (2003), Lack of standard communication procedure causes poor communication which consequently leads to rework. The authors reported that poor communication contributed 0.25% to the overall causes of rework in construction project. In line with Fayek, Dissanayake, and Campero (2003), Love, Edwards, Smith and Walker (2009) reported that poor communication during project execution was associated with frequent rework occurrence in civil and building projects. Mahamid (2016) opined that poor communication between client and other construction parties also may lead to conflicts between parties as well as misunderstanding of the contract document requirements, thereby negatively affecting the work flow. Consequently, the author ranked poor communication first among causes of rework having significant impact on residential building project. In view of this, "poor communication" ranked second among site management causes of rework affecting project time and cost performance in this study. This result corroborates findings from previous study (Love and Smith, 2003; Fayek, Dissanayake, and Campero, 2003; Oyewobi and Ogunsemi, 2010; Masterbroek, 2010 and Mahamid, 2016).

The ranking of poor planning and allocation of resources among the most significant factor affecting project time and cost performance supports the findings in previous studies which emphasised the importance of this factor (Fayek, Dissanayake, and Campero, 2003; and Love, Edwards, Smith and Walker 2009). In line with the adage "Failing to plan is planning to fail, Preis, Burcham, and Farrell (2014) emphasised that lack of appropriate project planning often results in the setting of unrealistic, overly aggressive goals which become serious delivery issues. Fayek, Dissanayake, and Campero (2003) opined that experience and technical knowledge is required for job planning and resource allocation to be effective and successful. The authors further reported that this factor contributes 2.51% to the overall causes of rework in construction projects. Simpeh (2012) also added that inadequate pre-project planning and poor resource allocation to project activities can increase errors, defects and poor workmanship. For this reason, the author ranked poor resource coordination third among causes of rework affecting project performance. However, failure to appropriately consider external factors such as cycles of extreme weather in offshore location can result in significant rework which consequently affects project performance. Hence the findings from previous studies support the results of this study which ranked "inadequate planning and resource allocation" third of all the site management-related causes of rework affecting project performance.

This study ranked "ineffective use of quality management practices" fourth among other site management-related causes of rework. This result agrees with findings of Love, Edwards Irani and Walker (2009) and Zaiter (2016) who noted that the implementation of an effective quality management practices reduces rework and consequently improve cost and time performance.

This study ranked "constructability issues" fifth among other causes of site management-related causes of rework in oil and gas projects. Constructability problems arising from safety issues and work environment are prevalent in construction projects.

Following this, Fayek, Dissanayake, and Campero (2003) reported that constructability problems stems out from inadequate access to work location. Their study further revealed that constructability issues contributed 0.31% to the overall causes of rework in heavy industrial projects in Alberta. Along the same line, Oyewobi, Abiola-Falemu and Ibironke (2014) opined that improper site investigations or unforeseen circumstances are largely responsible for causing rework in many projects. According to the authors, time exigencies preclude some contractors to perform comprehensive site investigation prior to execution. Instead, contractors therefore rely on visual inspection and, or unreliable feedback from people around. Hence, deficiencies in construction may occur as a result of failure of design or contract documents to capture such unforeseen circumstance.

Furthermore, this study has shown that both the frequency of occurrence and the influence of site-management related causes of rework on cost and time performance of oil and gas projects across the six states in the South-South zone of Nigeria as perceived by contractors and consultants are the same. The implication of this is that consultant and contractors do not consider project location as having influence on the way site management-related causes of rework affects project time and cost performances. Similarly, the two groups of respondents do not also consider the frequency of occurrence of site management-related causes of rework to differ across different states in the Zone. In other words, project location do not appear to moderate the influence of site management-related causes of rework on project performances. Moreover, that the opinions of contractors and consultants are not affected by project location agrees with the findings of Hwang, Thomas, Hass and Caldas (2009) where it was reported that there was no significant difference in the impact of rework on construction cost performance across different locations. Along the same vein, the report of Forcada, Gangolells, Casals and Macarulla (2017) – that there is no evidence of significant disparities in cost of rework across several regions in Spain also lends credence to the findings of this study. The significance of the result of this study is that it will encourage construction professional not to concern themselves with the influence of location on site management-related causes of rework as it affects time and cost performances, especially where projects are to be executed in different locations.

6. Conclusion and Recommendations

By comparing the perceptions of consultants and contractors, this study concludes that their opinion on the frequency of occurrence of site management-related causes of rework is the same. This implies that both contractors and consultants agree on the site management-related causes of rework that frequently occurs in oil and gas projects. In view of this, “ineffective site leadership”, “poor communication”, “poor planning and allocation of resources”, “ineffective use of quality management practices” and “constructability problems” were considered the five most frequently occurring site management-related causes of rework in oil and gas construction projects in Nigeria.

This study also concludes that the top five frequently occurring site management-related causes of rework have significant influence on cost and time performance of oil and gas projects in Nigeria. The implication of this result is that, their combined opinion on the frequency of occurrence and influence of site management-related causes of rework on cost and time performance may well serve as input in the development of strategies that will prevent the occurrence of site management-related rework in oil and gas project.

This study further concludes that the influence of site management-related causes of rework on cost and time performance of oil and gas construction projects in South-South Geo-political zone of Nigeria is significant. This implies that site management-related causes of rework affect time and cost performances. Therefore, mitigating site management-related causes of rework would result in an improvement in time and cost performance of Oil and Gas construction projects. This result suggests that construction professional in oil and gas sector of Nigeria should make concerted effort to prevent the occurrence of rework in oil and gas construction projects.

In this study, frequency of occurrence and the influence of site management-related causes of rework on project time and cost performances are the same across the states of South-South, Nigeria as perceived by contractors and consultants. Therefore, this study concludes that location has no effect on the frequency of occurrence and the way site management-related causes of rework affect time and cost performances of oil and gas projects. This implies that oil and gas projects could be sited anywhere in the region without entertaining concerns about project location contributing to the occurrence of site management-related causes of rework which in turn affect project costs and time performances.

Based on these conclusions, it is recommended that project owners and construction professional should develop and implement quality management training for project site team across the industry to enhance their knowledge and awareness on quality control as this would reduce the occurrence of rework and improve project performance. Furthermore, adequate time and resources should be made available for site verification prior to construction execution, as this would significantly reduce errors and omission which subsequently result in rework during construction. This study also suggests the need for effective resource allocation and optimisation during early project planning and execution to avoid fatigue and stress on labour resources which subsequently lead to rework.

REFERENCES

Adamu, K.J., Dzasu, W.E., Haruna, A. and Balla, S.K. (2011). Labour productivity constraints in the Nigerian construction industry. *Continental Journal of Environmental Design and Management*, 1(2): 9–13.

Alwi, S., Hampson, K. D., and Mohamed, S. A. (2002). Non value-adding activities: A comparative study of Indonesian and Australian construction projects. *Proceedings of the 10th annual conference of lean construction*, Gramado, Brazil, pp. 627-638.

Arain, F M. and Low P. S (2005). The potential effects of variation orders on institutional building projects. *Facilities*, *23*(11/12), 496-510

Clough R., Sears G., and Sears S., Segner, R. and Rounds, J. (2015). Construction Contracting, Seventh Edition, A Practical Guide to Company Management. John Wiley & Sons, 2015.

Durdyev, S., and Mbachu, J. (2011). On-site labour productivity of New Zealand construction industry: Key constraints and improvement measures. *Construction Economics and Building*, *11*(3), 18-33.

Enshassi, A., Mohamed, S., Mustafa, Z. A., and Mayer, P. E. (2007). Factors affecting labour productivity in building projects in the Gaza Strip. *Journal of Civil Engineering and Management*, *13*(4), 245-254.

Fayek, A. R., Dissanayake, M., and Campero, O. (2003). Measuring and classifying construction field rework: A pilot study. Research Rep. Available at: https://www.coaa.ab.ca

Forcada, N., Gangolells, M., Casals, M., and Macarulla, M. (2017). Factors Affecting Rework Costs in Construction. *Journal of Construction Engineering and Management, 143*(8), doi.org/10.1061/(ASCE)CO.1943-7862.0001324

Hwang, B. G., Thomas, S. R., Haas, C. T., and Caldas, C. H. (2009). Measuring the impact of rework on construction cost performance. *Journal of Construction Engineering and Management, 135*(3), 187-198.

Hwang, B. G., and Leong, L. P. (2013). Comparison of schedule delay and causal factors between traditional and green construction projects. *Technological and Economic Development of Economy*, *19*(2), 310-330.

Hwang, B. G., Shan, M., and Tan, E. K. (2016). Investigating Reworks in Green Building Construction Projects: Magnitude, Influential Factors, and Solutions. *International Journal of Environmental Research*, *10*(4), 499-510.

Hwang, B. G., Zhao, X., and Goh, K. J. (2014). Investigating the client-related rework in building projects: The case of Singapore. *International Journal of Project Management, 32*(4), 698-708.

Jaafari, A. (1996). Human factors in the Australian construction industry: towards total quality management. *Australian Journal of Management, 21*(2), 159-185.

Jarkas, A. M., Kadri, C. Y., and Younes, J. H. (2012). A survey of factors influencing the productivity of construction operatives in the state of Qatar. *International Journal of Construction Management, 12*(3), 1-23.

Jergeas, G. (2009). Improving construction productivity on Alberta oil and gas capital projects. *A Report Submitted to: Alberta Finance and Enterprise*. Available at: https://www.coaa.ab.ca

Josephson, P. E., Larsson, B., and Li, H. (2002). Illustrative benchmarking rework and rework costs in Swedish construction industry. *Journal of Management in Engineering*, *18*(2), 76-83.

Love, P. E. (2002). Influence of project type and procurement method on rework costs in building construction projects. *Journal of construction engineering and management*, *128*(1), 18-29.

Love, P. E., & Smith, J. (2003). Benchmarking, benchaction, and benchlearning: rework mitigation in projects. *Journal of Management in Engineering*, *19*(4), 147-159.

Love, P. E., and Edwards, D. J. (2004). Determinants of rework in building construction projects. *Engineering, Construction and Architectural Management*, *11*(4), 259-274.

Love, P. E., Edwards, D. J., Irani, Z., & Walker, D. H. (2009). Project pathogens: The anatomy of omission errors in construction and resource engineering project. *IEEE Transactions on Engineering Management*, *56*(3), 425-435.

Love, P. E. D., Edwards, D. J., Irani, Z. and Goh, Y. M. (2011). Dynamics of Rework in Complex Offshore Hydrocarbon Projects. *Journal of construction Engineering and Management,* 137(12): 1060-1070.

Love, P. E., and Sing, C. P. (2013). Determining the probability distribution of rework costs in construction and engineering projects. *Structure and Infrastructure Engineering*, *9*(11), 1136-1148.

Love, P. E., and Edwards, D. J. (2013). Curbing rework in offshore projects: systemic classification of risks with dialogue and narratives. *Structure and Infrastructure Engineering*, *9*(11), 1118-1135.

Oyewobi, L. O., and Ogunsemi, D. R. (2010). Factors influencing reworks occurrence in construction: a study of selected building projects in Nigeria. *Journal of Building Performance*, *1*(1).

Oyewobi, L. O., Oke, A. A., Ganiyu1, B. O., Shittu1, A. A., Isa R. B. and Nwokobia L. (2011). The Effect of Project Types on the Occurrence of Rework in Expanding Economy *Journal of Civil Engineering and Construction Technology*, 2(6): 119-124.

Oyewobi, L. O., Abiola-Falemu, O., and Ibironke, O. T (2016). The impact of rework and organisational culture on project delivery. *Journal of Engineering, Design and Technology*, *14*(2), 214-237.

Robin McDonald, C. C. M., and LEED, G (2013). Root Causes & Consequential Cost of Rework.

Mastenbroek, Y. C. (2010). *Reducing rework costs in construction projects* (Bachelor's thesis, University of Twente).

Mahamid, I. (2016). Analysis of Rework in Residential Building Projects in Palestine. *Jordan Journal of Civil Engineering*, *10*(2), pp. 197-208

Nepal, M. P., Park, M., & Son, B. (2006). Effects of schedule pressure on construction performance. *Journal of Construction Engineering and Management*, *132*(2), 182-188.

Norman, G. (2010). Likert scales, levels of measurement and the "laws" of statistics. *Advances in health sciences education*, *15*(5), 625-632.

Palaneeswaran, E. (2006). Reducing rework to enhance project performance levels. In *Proceedings of the One Day Seminar on Recent Developments in Project Management in Hong Kong. Hong Kong: Centre for Infrastructure and Construction Industry Development*. May 2006. pp. 1-10

Palaneeswaran, E., Love, P. E., Kumaraswamy, M. M. and Ng, T. S. (2008). Mapping rework causes and effects using artificial neural networks. *Building Research & Information*, *36*(5), 450-465.

Palaneeswaran, E., Kumaraswamy, M., Ng, T. S. T. and Love, P. E. D. (2005). Management of rework in Hong Kong construction projects. *Proceedings of the QUT Research Week 2005*, 4-5.

Preis, A., Burcham, D. and Farrell, B. (2014). Spotlight on Oil and Gas Megaprojects. Available at: http://www.ey.com/gl/en/industries/oil---gas/ey-spotlight-on-oil-and-gas-megaprojects.

Rhode, B., & Smallwood, J. J. (2002). Defects and Rework in South African Construction Projects. proceedings of the Royal Institution of Chartered Surveyors. pp.5-6.

Simpeh, E. K. (2012). An analysis of the causes and impact of rework in construction projects. Doctoral dissertation, Cape Peninsula University of Technology. South Africa.

Udofia, E.P. (2011). *Applied Statistics with Multivariate Methods*. Enugu: Immaculate Publications Limited, pp. 1 – 694.

Wasfy, M. (2010). Severity and Impact of Rework, A Case Study of a Residential Commercial Tower Project in The Eastern Province-KSA. King Fahd University. Dhahran

Zaiter, M. M. A. (2014). Causes and Effect of Rework on Construction Projects in Gaza Strip. A Dissertation in the department of Civil Engineering and Project Management, Islamic University of Gaza.

Zumbo, B. D., & Zimmerman, D. W. (1993). Is the selection of statistical methods governed by level of measurement? *Canadian Psychology/Psychologie Canadienne*, *34*(4), 390.