**Scope Change Management and Cost Performance in the Oil and Gas Industry: A Nigerian Case Study**

**Abstract**

The complexities and challenges peculiar to pipeline construction projects in the oil and gas sector with attendant changes in scope and costs are sources of stakeholder concerns. This necessitates making models and suggestions that can mitigate the effects of incidents of changes in project scope and consequent imports. This research examines the influence of scope change management on project cost performance in the Nigerian oil and gas industry. Using an explanatory case study, this study analyzes primary and secondary data to demonstrate, via correlation and regression, that effective scope change management significantly improves project cost performance.

**Keywords**: scope change, management, pipeline construction, project scope, project cost performance, correlation and regression.

**Significance Statement**

The study resolves the problem of scope change management in Nigeria’s oil and gas sector and how alterations in project scope affect cost performance. By applying a case study method, the research reveals the fundamental relationship between efficient scope management and increased project cost performance. Also, using correlation and regression analyses, the outcomes highlight the financial effects of scope modifications by showing a candid correlation between scope inflations and enhanced project costs. The study adds to how innovative frameworks can be made and used to reduce cost blowouts; it advocates more eco-friendly project practices in the global oil and gas industry, making it useful for industry stakeholders and scholars.

1. **Introduction**

The oil and gas industry is the major contributor to the economy of Nigeria, and according to the National Bureau of Statistics (Nigerian), the share of oil and gas in total of the country's GDP was 9.11%, 10.51%, 8.60%, and 6.69% for 2017, 2018, 2019, and 2020, respectively. The government continually invests in capital projects in the sector to improve productivity and earnings from oil and gas, while the case study project is expected to boost the Nigerian GDP. The contract firm was engaged to undertake the designing, engineering, procurement, and construction activities with a scope that covered two different lots. However, the project started with a contract sum of $588,256,172.94 for two years but rose to $775,311,801.58 in the 9th year—7 years beyond the initial contract duration. The above brings to the fore the usual concerns exhibited by stakeholders about project scope change vis-à-vis the final cost of execution. Ref. 2 posited that interest is growing in the effects of changing scope on time and cost overruns during project implementation. Ref. 3 affirmed that scope change management is a functional-oriented problem that requires developing sustainable techniques that remain elusive.

**2.0 Literature Review**

This section examines the extant literature on the research topic, its variables, and the reviews of related empirical studies, explaining the main concepts of the research work and the theory that forms the basis for the study.

**2.1 Conceptual Issues**

Scope Change and Project Cost

Ref.4 describes project scope as everything concerning the project, the content of work, or the total prospect in the background of the outcomes. This is defined as the borderline of the project and the documentation of agreement 5. Scope change may inform work or structural redesign, rescheduling, recapitalization, equipment/asset upgrading, and skill development. Work could be rescheduled for ethical, legal, social, cultural, and political dynamics, thus changing the scope of work. Changing government policies and the legal framework could affect contract execution by increasing or reducing the work content. Legislation against the involvement of women and children in construction would introduce a new work and ethical order. The sudden declaration of public holidays based on politics and culture will affect time and work schedules and ultimately the cost of execution of the project.

Ref.5 stated that scope change enlarges cost overrun and schedule slippage elements. The cause of scope change was categorized as an external event, a blunder in describing the work range, or a value-count change 6. Ref.7 mentioned that the necessity for scope change could be related to precautionary or remedial activities or repairs; while Ref.6 recognized two main impacts of scope change as schedule and cost. Project scope change could necessitate an increase of investment capital by project executors due to the larger scale of operation. New equipment may have to be purchased while old assets may be calibrated to meet demands from the new scale of work. With the enlargement of scope, there may be a need for employee skill improvement and engaging new personnel with the desired skills.

However, scope change is not all about increased cost or incurring losses, rather, it could translate to financial, economic, and social benefits for stakeholders with efficient scope management. As espoused in this research, effective scope management - through careful control, strategic planning, and clear communication - can modify scope change to become feasible opportunities for growth. This process may inject new capital into the project, create new jobs, and enhance the social and economic well-being of the community. A sudden increase in the level of operation could bring about investment opportunities and growth potentials, especially where efficiency is achieved.

**Project Scope Management**

Scope management is the vital process that ensures that project work contents are limited to only the job necessary to achieving the project intents as specified in the project agreement8. In other words, project scope management identifies, plans, communicates, and controls the work content of a project9. This study considers scope control, scope planning, and communication as the main aspects of scope management.

Scope control

Changes in the project scope cannot be forestalled totally; therefore, it should be regulated. Hence, scope management involves monitoring the project status, deciding if scope change has happened, and controlling the integrated changes with other aspects of the project that influence the changes in scope10. According to Ref.5, Scope control is the feature of scope management that ensures that expected scope standards are predetermined in the light of the industrial experience to establish benchmarks for checking deviation. Scope control functions well with a strong communication system by providing feedback for necessary amendments.

Communication

Ref.11 stated that for a successful project outcome, management must establish good project information or communication procedures. Such a procedure will ensure the preparation of timely and adequate dissemination of project information. Ref.7 maintained that all units must be encouraged to submit inputs to assist in process scope control, ensuring the change control system is strong and sustainable. The responsibilities and duties of the control board should be transmitted to stakeholders. When it is determined that scope change is inevitable, the decision must be documented, integrated, and communicated to all on time.

Change Management Plan

This is the highlighting of the change management procedure and it is often prepared by teams of experts. The project team must also be part of the preparation of the management plan which should be verified and updated periodically. Scope planning entails scope requirement scheduling which involves the collation of the project necessities, the project needs ranking, defining the structure to process the requirements, and managing the structure12. It consists of the statement of project scope, documenting the assumptions, documenting the constraints, defining the needs of the business vis-a-vis the needs of the client, and involving the client in the life cycle phases of the project.

**Project Cost Performance**

Ref.7 described cost performance as the outcomes of project execution in terms of cost efficiency, the comparison of the value of the project to the actual project cost, and the provision of insights into its predictive analysis. The cost performance index measures the earned value of the project in ratio to the original budget of the project. It is an indicator that enables project performance measurement and indicates if the project is progressing in line with the allotted fund. If the CPI is 1, the project is performing as budgeted but when it is less than 1, it is over budget; while a CPI higher than 1 indicates that the project is performing well against the estimated budget.

**2.2 Theoretical and Empirical Literature**

**Theoretical Review**

The change theory of improvement science, with its foundation laid by Walter Shewhart in the 1920s and 1930s forms the theoretic basis for the research work4. Improvement Science depends on inquiry that involves painstaking measurements and data analyses with Networked Improvement Groups. Ref.9 affirmed that Improvement science has to do with changing practices that improve performance by applying research-based practice to modify current practices. Since evidence has indicated that scope change is unavoidable in project implementation, stakeholders should work on models that will enable practitioners to mitigate the effect of changes in scope on project performance.

The related model (the fitted regression model) was derived from the linear regression equation having observed the related assumptions:

The research model in mathematical equation terms.

The main thesis of this research is explained by the theorized relationship envisaged between scope management and project performance. The conceptual model is explained in Figure 1 below:

**H1**

**Scope Management**

* Scope control
* Communicating change
* Change planning

**Project performance**

**Dependent variable**

**Independent variable**

***Figure 1: Conceptual Model***

The above figure suggests that scope change management influences project performance as it explains its variations, while project cost measures cost performance; portraying scope management as measured through scope planning, scope control, and scope change communication as predictor variables and project performance as response variables.

**Empirical Review**

At the global level, Ref.4 assessed the effect of scope change on the project plan and overall project cost with PERT scheduling. The study revealed that scope change influences budgets and the final expense of projects. Ref.13 examined the connection between project scope readiness and project performance in the mining industry in Namibia. The study involved a survey of ten projects, using the Pearson coefficient of correlation for measurement, and shows that project scope definition increases schedule performance. In the same vein, Ref.9 evaluated the effect of project scope change management on the performance of fishing projects in Kenya; in descriptive research that utilized correlation coefficient and regression to analyze data. The research revealed that a relationship exists between monitoring and project performance. Ref.14 studied the use of project scope management practices on project success in the telecommunication industry in Nigeria, employing the means and regression analysis to measure the variables. The result shows that customer expectations, client satisfaction, and resource allocation affect project success.

**2.3 Gaps Identified in Empirical Literature**

Even though most of the reviewed studies converged in concept and findings, they differ in methodologies and contexts. Ref.13 focused on scope change in the mining industry in Namibia while Ref.9 and Ref.4 studies were centered on fishing projects in Kenya and building projects in Sudan, respectively. These studies applied different methodologies: coefficient of correlation, percentage frequencies, and PERT analysis with outcomes and evidence from other countries. These findings are not generalizable to Nigeria due to differences in business climates, culture, and legal frameworks. Ref.14, the only local article considered for review dwelled on factor analysis as against the relationship among variables; revealing a conceptual gap. Since the application of different methodologies in similar studies with diverse backgrounds and concepts may reveal different results, this study strives to fill the evident methodological, contextual, and conceptual gaps by investigating the relationship between scope change and project cost with a Nigerian case study project in the oil & gas industry.

**3.0 Research Methodology**

The related model was derived from the linear regression equation having observed the related assumptions:

In equation 1, is the estimate of the value of the dependent variable (project cost performance).

is the average (constant) value of when x is zero.

is the average change in (project cost) associated with a unit increase in x (scope change).

equals the value of the dependent variable (project cost performance.

is the error term.

From the unstandardized coefficients in the data analysis procedure, the regression equation (2) was derived from equation (1) above:

the fitted regression equation model.

Where *x* = (equals) the unit of scope change and

project cost performance (*y*) = (equals) 575618241.489 + 9664911.653 (scope change).

Scope management was measured through scope control with evidence of scope standard setting, benchmarking, checking, and correcting deviations from scope standards. Scope planning was appraised on the evidence of change management standard procedures, project team involvement, scope requirement plans with implementation, and periodic review of change management plans. Communication was assessed through evidence of documentation of change procedures, established project reporting systems, change information dissemination procedures, and timely feedback. The cost performance index was measured through available secondary cost data. Hence, the study proposed the following hypotheses for evaluation:

H0: There is no significant relationship between Scope change management and project cost performance.

H1: There is a significant relationship between Scope change management and project cost performance.

The research was conducted using the case study approach. This approach is appropriate for the study as it affords the prospect of studying an aspect of a research problem in detail. The study adopted the survey design method with primary and secondary data. The primary data collection was through structured questionnaires with item measurement by a 5-point Likert scale; while secondary data was collected from the project reports from the case study unit. The purposive sampling technique was espoused with participant managers who are knowledgeable in the relevant research area, having a population of 15 personnel. These experts are samples from major departments of the firm and are the units of observation for the study. All variables on the instrument had Cronbach's Alpha (α) of above 0.70. As a rule of thumb, an acceptable alpha coefficient was set at least 0.70 or above 4. Hence, the administered questionnaire is reliable. The study estimated the commonalities for each variable and all factors extracted had a coefficient of above 0.4; thus, establishing the construct validity of the questionnaire15. Descriptive analysis was adopted to examine the rationality of the distribution, while regression analysis was utilized to test relevant hypotheses.

**4.0 Results and Discussion of Findings**

This study used SPSS and Excel tools to examine descriptive and linear regression analyses to measure the relationship between scope change management and project performance.

**Data analysis**

4.1. Descriptive analysis

The outcomes of the descriptive analyses are presented below:

**Respondents’ Years on the Project**

The years of respondents' experience on the project shows 8 respondents were with less than 6 years on the project, representing 53.3% of participants, while 6 respondents with between 4-6years' experience are 40% and 1 respondent spent between 1-3years on the project, forming 6.7% of total respondents. This reveals that none of the respondents have less than one year of experience on the project, while one participant (6.7% of respondents) had over a year of experience on the project. 40% and 53.3% of the respondents had between 4-6 years and above 6 years respectively on the project. Hence, all the observation units are well-informed about the project, they have the required experience and competence to provide credible evidence on the circumstances and processes of the project.

4.2 Response to Scope Change and Cost Performance

The responses to questions on the effects of scope change on cost performance produced a statistical mean of 6.04 for agreed; followed by a 4.3 mean for strongly agreed. The data shows that respondents' degree of agreement with the questions on the influence of scope change on performance is high as the means statistic indicates an average perception, and it is less than 2 for neutral, disagree, and strongly disagree. Hence, all respondents agree that scope change management affects project performance.

4.3. Regression Analysis

The model for this research was derived from the linear regression equation:

A univariate analysis was performed to examine the influence of scope change on project cost. The null and the alternative hypotheses are stated as follows:

H0: β1 = 0

H0: β1 ≠ 0

Using the SPSS for the analysis of the linear regression, the measurement of the research model is as follows:

***Table 1: MODEL SUMMARY***

|  |  |  |  |
| --- | --- | --- | --- |
| R | R-Squared | Adjusted R-Squared | Std. Error of the Estimate |
| .984 | .968 | .964 | 14663499.4 71 |

***Source: self-processing***

In the above table, the coefficient of determination-R2 indicates that the percentage of the total variance explained by the independent variable (scope change) is 96.8%. Pearson's product-moment correlation coefficient (R) of 0.984 shows a strong association between the two variables. R² of 0.968 indicates the proportion of total variance (S²) that is explained by the linear regression, with a positive value clarifying that as scope increases, project cost also increases.

***Table 2: Regression Coefficients for project cost and scope change***

Unstandardized Coefficient

Standardized Coefficient

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Model | B | Std Error | Beta | t | Sig. |
| Scope change | 9664911.653 | 659742.031 | .984 | 14.650 | .000 |
| constant | 575618241.489 | 9304208.074 |  | 61.866 | .000 |

***Source: self-processing***

The coefficients for each variable assist the researcher in evaluating the importance of the independent variable. In this research, the unstandardized and standardized coefficients are stated for the regression equation in Table 2. Based on the unstandardized coefficients in Table 2 above, the regression equation was derived as follows:

(From equation 1)

where *y* = cost performance and *x* = scope change.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Model | *df* | Sum of Square | Mean Square | F | Sig. F |
| Regression | 1 | 4614479552 2573472.00 | 461447955 22573472.00 | 214.609 | .000 |
| Residual | 7 | 1505127517 076558.50 | 215018216 725222.66 |  |  |
| Total | 8 | 4764992303 9650032.00 |  |  |  |

***Table 3: ANOVA***

***Source: self-processing***

The analysis of variance for linear regression could be made from the results in the ANOVA table 3, above.The relationship between scope change and project cost is significant as the p-value (0.000) was less than the significance level (0.05). Therefore, we can reject the null hypothesis that scope change has no significant effect on project cost. This conforms with the aversions by Ref.4, Ref.9 and Ref.11.

From Table 2, The regression line of fit which explains the relationship between scope change and project cost is derived and it replicates the regression equation, *y* = 575618241.489 + 9664911.653*x*. Where 575618241.489 is the intercept and 9664911.653 is the slope. The findings indicate that project cost will have an index of 575618241.489 when scope change is held constant. In addition, the Beta coefficient of 9664911.653 shows that an increase in the project scope will increase project cost by $9,664,911.65. This is the extent of the financial input that will be made each time the project scope is altered. This indicates that the cost would remain at $575,618,241.49 when there is no change in project scope. Hence, the fitted regression model: Project cost (*y*) = (equals) 575618241.489 + 9664911.653 *x* (scope change). The findings highlight the importance of scope change management in the achievement of project cost performance connoting that scope change management influences and affects project cost performance

**5.0 Conclusion and Policy Recommended**

This study deduces that a strong relationship exists between scope change management and project cost performance, averring that scope change has a positive and statistically significant influence on the cost of a project; while underscoring the vital effect of scope change on project cost. This indicates that an improvement in scope change management will lead to direct betterments in project cost performance. Specifically, the study found that scope change management affected project cost performance in the engineering procurement and construction of the Obiafu/Obrikom-Oben (083) gas pipeline project in Nigeria. However, when a model of the relationship between scope changes and project costs is established, project management will be guided on the optimal level of project scope change activities vis-à-vis the related execution costs. The discontinuation of the mismanagement practice of project scope will ensure that fund loss due to poor control of scopes could be saved and utilized for business growth or further investment. Hence, making a robust template to control scope change and its impacts will result in having resources that could be deployed to assist in more economic growth in Nigeria. Given this, project executors should establish measures to evaluate change proposals before approval, ensuring that cost control mechanisms are installed before execution.

This research work like other related studies has its strength and limitations. Hence, the study thereby offers the following suggestions for future research to improve its core values:

1. Perform this research with big data using emerging technologies such as blockchain to improve scope change management and artificial intelligence devices to formulate relevant predictive models.
2. Conduct future research that focuses on utilizing in-house measures to determine the drivers of project scope management.
3. Further research is determining the impact of scope change on project quality, safety, and labor productivity.

**Originality/value**

To the best of the knowledge of the authors, this study is the first to examine the influence of scope change management on cost performance, using a multimillion-dollar oil and gas project in Nigeria as a case study.

**Funding**

The authors received no funds for the research.

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