 

# Optimization of Cost and Quality in Oil and Gas Construction sites: A review

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**Abstract**

For a successful project delivery in the oil and gas construction site or in any other clime, the optimal values of cost and quality must meet the expectations of the client. Unfortunately, there have been incessant expectation gaps in most projects. An extensive literature review, traceable to a number of persuaded researchers, of the current project framework has painstakingly revealed, about 70 associated criteria derived as sources of the sustained failure of cost and quality optimization objective. Fundamentally, in construction works, cost overruns as well as quality nonconformity result from a breach of these optimal values and lack of the requisite dynamic intervention strategic planning to restore the balance of the system being delayed or absent. Cost and quality optimization, therefore are anchored on sustainable planning, monitoring and controlling procedures (before, during and after) in all the construction activities regarding manpower, materials, machineries and methods requirements. From works of literature, a hybridized approach that combines a modified composite Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) with the Analytic Hierarchy Process (AHP) is proposed for the objective cost and quality optimization in the oil and gas sector. This preferred method finds credence to the comprehensive criteria weighting factors. Therefore, this proposed validated model should be utilized in future optimization efforts in oil and gas construction as a modified hybrid MCDM algorithm.

**Keywords:** Optimization, cost, quality, composite TOPSIS/AHP, decision, construction site

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## 2. Introduction

The dire deficiency optimization of fundamental objective variables such as cost and quality to compensate for continual failed project performances has frequently led to cost overruns, non-conformances, and, in some cases, outright rework or rejection of project quality. This has challenged decision-making processes among key responsible stakeholders/personnel in the construction sites, especially in the oil and gas industry. This persistent problem prompted this research topic. The immediate reason is available: the usual associated significant budget in the oil and gas business activities and the expediency of the role of oil and gas industry in the global economy. According to various international economic and social development indices, such as the total gross domestic product (GDP), Kenny (2007) stated that the construction sector is valued at USD 1.7 trillion globally and typically accounts for 5–7% of the total gross domestic product (GDP) in most countries (Alaloul et al., 2021). While oil and gas remain among the most essential commodities in the world economy, construction is expected to rise from 12.4% in 2014, it is projected to account for 14.7% by 2030 (Global Construction Perspectives, 2015). The oil and gas industry represents approximately 3% of the world's GDP (World Energy Forum, 2022). In the United States, the oil and gas sector alone contributed 4.8% of GDP in 2020 (U.S. Energy Information Admin, 2020). In Nigeria, for example, the construction market is predicted to grow by 160% by 2030 (Global Construction Perspectives, 2015), and the oil sector contributed 6.63% to the total real GDP in Q1 2022, a decline from 9.25% in Q1 2021 (Nigerian Bureau of Statistics, 2022). In the world economy, Countries rich in oil and gas reserves play significant roles in global decision-making processes. Mohaddes and Raissi (2019) emphasized the importance of this oil and gas to the worldwide economy, highlighting their critical contribution to the GDP of many nations with commercial deposits in these resources. The relevance of the petroleum industry, especially among the energy sector internationally has been of a pivotal essence contributing enormously to the total GDP of most countries that have them in commercial deposits.

Despite the significant contributions of various project management constraints, cost and quality remain paramount. Customers (end users) are generally more concerned with the cost and quality of a product or service than with the amount of input time required to complete it. These factors largely define customer satisfaction. Importantly, the quality of a product is assessed from the customer's viewpoint, focusing on two key aspects: expected product quality and perceived product quality (Razak et al., 2016). While quality alone determines the durability of a product, when optimized in conjunction with cost, it serves as an expression of the product's appropriate pricing. This threshold is what optimization modelling tries to establish.

The objective of continuous improvement programs are not only to meet customer requirements, but also to do it at the lowest cost, which can only happen by reducing the costs needed to achieve the quality (Vaxevanidis et al., 2008).. Also, Rasamanie et al., (2011), highlighted that the global highly competitiveness have made quality costs as a useful tool to monitor and achieve costs reduction to remain competitive. Effective project planning takes into account several critical factors, including time, cost, quality and risk/safety management which are essential, but conflicting to one another in nature, impacting project delivery (Nwaneri and Anyaeche, 2018). Those are achieved with appropriate professional ethical procedures.

A project is said to have failed when the delivery is short of what was the original expectation of the business case objective and of the sponsor stakeholder. According to the researchers, Venczel et al., (2021); Machado and Martes, (2015); Westerveld, (2003), project management success is determined by meeting management objectives in terms of time, quality, and cost; product's objectives: customer satisfaction, technical specifications, and functionality; and project's potential in terms of reputation, revenue, market share, and competitive advantage respectively, which contributes to the company's long-term success (Albtoush et al., 2022). Streamlining further those success parameters, Liyanage and Villalba-Romero (2015), posited the six (6) success criteria in construction projects: time, cost, quality, contract process, results, and stakeholders' satisfaction. On the contrary, project failure, therefore, manifests as inability to deliver a project to time, cost and quality specifications, or inability to satisfy consumer expectations (Amachree, 1988).

Therefore, it is imperative to conduct a critical literature review to determine how existing research addresses the optimization of cost and quality while identifying knowledge gaps for future work in this subject area. The current work provides the analysis of the literature at recognizing these gaps in the oil and gas sector.

## 2. Research Methodology/ Material and Methods

In this section of the research, the approach adopted to synthesize relevant literature on the optimization of cost and quality in the construction sites of petroleum industry includes the thorough review of the existing studies. This was skilfully achieved by exploring the numerous well-known and readily available international online databases: ScienceDirect (www. sciencedirect.com), Researchgate (https://www.researchgate.net/), Academia (https://www.academia.edu/), Google Scholar (https://scholar.google.com/), and Scopus (https://www.elsevier. com). Additionally, a local resource such as the Bureau for statistics (https://nigerianstat.gov.ng/) was also explored. Reference materials from international organizations such as the American Welding Society (AWS) and Project Management Institute (PMI) were also consulted. Some key search words/terms included, "optimization", "optimization techniques," "cost and quality optimization," "optimization in oil and gas industry," "cost and quality in the oil and gas construction sites," and 'oil and gas construction sites."

Cumulatively, amidst the above online resources, a mix of hundreds of research articles, prominently from high impact and peer reviewed journals were downloaded and reviewed for relevance to the study, credence to the focal topic of discuss and an enhanced manageability. Additionally, the now aggregated articles were deeply studied in much more details as to filter the most appropriate relevant areas that address the study situation. Table 3.1 shows the summary of related research works, findings and the knowledge gaps from several reviewed literatures to the study.

Fundamentally, it was deduced that cost overruns when incurred in a project tend to end in unsuccessful delivery depending on the degree of the overspent especially when the desired intervention is not swiftly administered. Similarly, in projects, nonconformity of sorts can be a source of cost overruns manifesting in project incidents or accidents throughout the project lifecycle.

## 3.0 General Construction Site Management and Optimization

According to the Project Management Institute (2013), a project is a temporary undertaking aimed at creating a unique product, service, or result. This temporary nature indicates that projects have a definitive start and end. A project is complete when its goals are met, cancelled because they cannot be achieved, or deemed unnecessary. Additionally, a project may be terminated at the request of the client (customer or sponsor) (PMI, 2013).

The Table 3.2 below presents summary of the literature review on a typical grouped alternatives' details of project cost and quality objectives. Generally speaking, in a typical construction site management project, there are established standards and guidelines, to measure, monitor and control the outcome of its project delivery (virtual or physical): general construction, CMAA, (2021); project management, (PMI, 2013); welding, AWS D1.1, (2020); cost, CMAA (2018); quality, ISO, (2015); safety, pipeline, etc. Many of those guides are meant for particular construction field of specialty as they are articulated by subject matter experts to address specific immediate challenges. They are usually commenced in the base office and perfected in the construction sites. This is typical of such a project. For a successful project delivery, there are set criteria, objectives and expectations that are spelt out to ensuring all the stakeholders, internal and external, are satisfactorily carried along during and after product and service delivery. The project success definitions and status may somewhat differ in specific components delivery; however, basically the principles and strategic processes remain the same: expectations are met. During execution stage of construction projects, the raw materials are naturally and relatively domiciled on or near to site and therefore profitable in terms of proximity, economic viability and convenience. That is primary economics.

Virtually all the defining factors of construction management have bearing, directly or indirectly, on the acceptable optimal performance of cost and quality. According to Iskandar and Allmendinger, (2021), it was stated that managing construction projects as to conforming to the objective requirements as set out by the client to the contractor and subsequently achieving the greatest balance of cost and quality, is a multifaceted, resource-intensive, and risky endeavour. This process involves the contractor's organization and the management of skilled individuals from the design phase through to the completion of the construction project. World over, critical factors such as quality, scope, time and cost for performance of a construction project are usually important and crucial to both the client (employer) and contractor while observing all the necessary established standards, codes and best practices to ensure the requisite quality and purpose are not compromised.

Table 3.1 Summary of Literature findings and the knowledge gaps

| **Literature** | **Objective** | **Summary of output** | **Gap** |
|---|---|---|---|
| Composite Multi-Criteria Decision Analysis for Optimizing Hybrid Renewable Energy Systems for Nigeria's Geopolitical Zones (Ukoba et al., 2020) | 1. To evaluated various hybrid solar PV-wind-biomass systems based on technical, economic, socio-cultural, and environmental factors, utilizing TOPSIS and AHP algorithms. | 1. HOMER software was favored for optimal configurations.<br>2. TOPSIS-AHP method was employed for the analysis<br>3. The biomass generator-solar PV-battery energy system (GPBES) was the best option across all zones, with a competitive cost of energy (COE) of \$0.151–\$0.156 per kWh. | 1. Further need for development of an effective MCDM method for analyzing optimal hybrid systems in relation to social, cultural, economic, technical, and environmental factors |
| AHP-TOPSIS Method for Learning Object Metadata Evaluation (İnce et al., 2017) | The use of a hybrid AHP-TOPSIS method for evaluating ad selecting Learning Object (LO) metadata | 1. The method effectively produces suitable content from LO metadata.<br>2. It marks the first application for LO selection.<br>3. The ranking distribution using hybrid AHP-TOPSIS outperformed AHP and TOPSIS | 1. AHP alone showed indistinguishable LO point distribution, while TOPSIS was better than AHP but less effective than the hybrid approach |

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| | | individually and distinguishably | |
| Modelling the effect of project cost management on project management performance: an application of SEM to Namibian MRCs (Nandjebo et al., 2021) | To show how concentrating on essential cost management areas may enhance project timeliness and quality with emphasis on critical elements. | Cost reviews of previous projects and financial management implementations highlighted critical aspects of project cost management | 1. No optimization approach |
| "Significant Factors Causing Cost Overruns in the Construction Industry in Afghanistan" (Niazi & Painting, 2017) | key responsible factors for cost overruns in the Afghanistan Construction Industry | 1. Corruption<br>2. Delays in progress payments by owners<br>3. Financing difficulties for contractors<br>4. Security issues<br>5. Change orders from owners during construction<br>6. Market inflation | 1. Immediate improvements in industry capacity and performance<br>2. A strategy for better cost performance<br>3. Measures to prevent further project failures. |
| Effective Cost Management and its Performance Evaluation Strategy (Enyinche & Omorogiuwa, 2022) | To proffer strategies for effective cost management and performance evaluation. | Inaccurate and inadequate cost estimation often stems from deficiencies in the initiation and planning phases of project management, leading to cost overruns. | However, no optimization model was proposed |
| The Time-Cost-Quality-Risk Trade-Off Model in Magnetic Resonance Imaging Machine Installation Project (Nwaneri & Anyaeche, 2018) | To create an optimization model for the fuzzy Time-Cost-Quality-Risk Trade-off (TCQRT) problem in an MRI machine installation project. | 1. Establishment of Multi-objective Genetic Algorithm (MOGA).<br>2. The TOPSIS ranking method proved effective.<br>3. Time, cost, quality, and danger are all trade-offs. . | 1. The model lacks flexibility compared to other techniques.<br>*2.* No strategies for improvement were provided. |
| Factors Affecting the Accuracy of Cost Estimate in Construction Projects: A Review (Albtoush et al, 2021) | The consequences of cost estimation in construction project among different countries. | 1. Limited time for estimates due to deadlines<br>2. Unreliable cost information<br>3. Unclear drawings and specifications<br>4. Inexperienced estimators<br>5. Incomplete cost data<br>6. Project type and location | 1. The suitability of the time allocated for contract documentation review.<br>2. The minimum required experience for estimation teams.<br>3. Strategies for optimizing recommendations. |

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| Stakeholder Engagement: Past, Present, and Future (Kujala et al., 2022). | To clarify the construct of stakeholder engagement by identifying its various components elements, objectives, activities, and impacts | 1. Definition and identification of stakeholder engagement components.<br>2. A guide for future research.<br>3. An examination of the negative aspects often overlooked. | 1. The need for an integrated view of both positive and negative aspects.<br>2. Exploration of new philosophical frameworks across various contexts.<br>3. A focus on the importance of heterogeneity.<br>4. The absence of a model for measuring theoretical rigor and practical relevance. |
| "Ethical and cost performances of projects: A canonical correlation" (Ogbu & Asuquo, 2019) | To examine the connection between unethical tendering practices and project cost efficiency in the Nigerian public sector. | 3 contractor-based factors:<br>1. Bribery to access confidential tendering information.<br>2. Overstating capacity and qualifications to secure contracts.<br>3. Using multiple firms by the same owner to bid on the same project<br>4 clients/consultants-based factors:<br>1. Sharing more information with preferred bidders. | Suggested measures to limit undue influence by executives on the tendering process directly or indirectly. |
| Effective techniques in cost optimization of construction project: An review (Rajguru and Mahatme, 2015) | To efficiently deploy the various tools and techniques in project construction management for optimal cost performance mix. | 1. Systematic planning and effective management are crucial for timely project completion.<br>2. Various optimization tools and techniques are available.<br>3. Enhancing a single stage of the construction process may not be an effective method for overall efficiency. | |
| "An Appraisal of Construction Management Practice in Nigeria" (Ugwu and Attah, 2016) | To identify factors affecting construction management in Nigeria and assess their severity using the Relative Importance Index. | 1. Conflicting design information<br>2. Effective resource coordination<br>3. Critical path method<br>4. Materials availability<br>5. Timeliness<br>6. Civil strife<br>7. Team identification<br>8. Lack of construction management knowledge. | 1. No optimization model was proposed<br>2. No strategic approach to effecting the found result |

In the oil and gas construction site, the cost of a project is aimed at a minimal, and the quality a process activity that must not fall below its acceptable minimum quality requirements. Otherwise, means a quarantined product for a rework or even outright rejection; that activity of the project is characterized by a certain level of originally defined acceptance criteria (usually controlled, monitored, and validated by the Factory Acceptance Test (FAT) or the Inspection and Test Plan (ITP) or, for pipelines, the hydrostatic pressure test, as well as being subjected to acceptable safety/risk factors to all stakeholders (Nwaneri and Anyaeche, 2018). Therefore, the project planning and organizing stage is as important as quality assurance, QA. This quality assurance is usually built into the conceptual construction system process as the "confidence level of the quality expectations" before the eventual take-off of the project (Ugwu & Attah, 2016).

Inherently, in a typical construction site project, the degree of complexities for each site activity remains unique, both in construction and management challenges, and consequently tends to present differing intricacies in terms of their various project management success criteria. Corroborating this, it was posited that the construction industry is complex and dynamic; each project is unique, requiring interaction among various professionals from different disciplines and companies. They must align their diverse visions and products to achieve the specific project objectives (Muñoz-La Rivera et al., 2021a; Muñoz-La Rivera et al., 2021b).

A crucial factor in the success of construction projects is effective risk evaluation. Managing risks involves analyzing the project scope to account for variables such as weather (rain, wind), and terrain etc. Construction sites often face unpredictable weather, limiting control over factors like wind, rain and light levels (Ahmed, 2019). Associated high-risk activities, such as painting/coating and electrical works in the rain, result in sure rework or could be fatal in some cases. The aftermath gives rise to cost overruns and quality compromise. In the petroleum industry, the popular slogan remains, "If it is not safe, don't do it''. Safety is everyone's responsibility, and this principle must be strictly upheld.

Managing oil and gas construction site projects is a complex, resource-intensive, and risky task involving the organization and management of people skilled in all the project life cycle areas from design to completion. Starting a construction project entails planning the allocation of resources and labour while guaranteeing that the output (for example, pipeline installation) is consistent with the specified quality requirements and is delivered on time and within budget without breaching contractual obligations (Iskandar & Allmendinger, 2021).

Prabhakar (2017) argued for improving scheduling practices by integrating quality management systems, concluding that these systems should be essential especially throughout the site activities: procurement, construction, fabrication, and installation processes. The importance of this perspective approach could be better appreciated from the perspective of implementing due diligence to all the necessary quality requirements, per time, strictly as specified during execution without compromise, contrasted with trying to keep to the apportioned time of an activity by the scheduler. A typical quality acceptance criteria requirement time that must be respected could be referenced from AWS D1.1 Structural Welding Code—Steel. Both ASTM A514, among the quenched and tempered high-strength steel plate materials, together with ASTM A 517 (Pressure Vessel Plate of Alloy Steel): they require NDT (visual or otherwise) inspections be conducted on them only after 48 hours following the completion of welding. The reason is anchored exclusively to ensure no cold cracking on the weld (AWS D1.1, 2020). So essentially, understanding the requirements of the specifics of particular/various construction activities and expectations to enhance effective execution forecasts must be adhered to for optimum cost and quality delivery.

A study by Rui et al. (2018) on oil and gas development in Nigeria found that projects had an average cost that exceeded initial estimates by 38%, indicating poor performance compared to global ideals. The significant underperformance could be attributed to some local challenges such as insecurity, local content and corruption values.

### *3.1 Cost and quality amidst construction site constraints*

Multi-objective optimization involves more than one objective function to be optimized simultaneously and has been applied to many fields of science, including engineering, where optimal decisions need to be taken in the presence of trade-offs between two or more objectives that may be in conflict (Chang, 2015).

The very core essence of the study exercise is to rightly interpret the proper contributing mix of each of the objective variables to the entire closed process of management; multi-objective optimization, at any instance, consequently calls for competence and in-depth understanding, by the project manager and his skilled team, of the mechanism of the various competing constraints. And when these requisite competencies and skill sets are absent, the aftermath is usually counterproductive. So the quest for the optimal objective values must be emphasized at each point in the project delivery.

The studies by Babu and Suresh (1996) showed that project crashing affects project quality when the quality expectations are compromised. Hired labour, for instance, was just increased with more mobilized equipment (cost increase) to the site, but with less attention to the level of the skill set (quality) of the increased hired workforce. Embarking on that alone would be tantamount to multiplying the level of project-associated risk. Customer satisfaction and expectations become uncertain. According to several researchers, the following factors have been identified as peculiar criteria that define the optimal values of cost and quality in construction sites of the oil and gas sector. Table 1 summarizes the various contributory criteria as highlighted by Niazi and Painting (2017) below.

### *3.2 Applicable optimization techniques*

Alwan (2016) summarized the following optimization process steps to the model: the definition of the real optimization problem, the objective, the selection of the decision variables, and the definition of constraints. In the final analysis, the formulation of the model is the presentation of the defined objective as a function of the variables and the constraints as functional relationships, equalities, and/or inequalities of the variables. The constrained model has consistently emphasized decision variables, the objective function, and business constraints (Babu and Suresh, 1996).

Optimization performance of whatever techniques must be targeted at increasing the efficiency level, or otherwise it would only lead to missing out on suitable benefits (Rajguru & Mahatme, 2015). Optimization of an inaccurate model is modestly illuminating at best and misleading and a waste of time at worst, and oftentimes, its algorithms will exploit weaknesses in the model if they exist (Alwan, 2016).

Natural intelligence is proving not sufficiently replicated for speed, complexities, and multiplicity in enhancing productivity and fluidity within a specified time frame as artificial intelligence (Darvazeh et al., 2021).

#### *3.2.1 Evaluation of optimization techniques*

The conventional technique is mostly deployed in manufacturing, logistics, and other operations problem evaluations, while the modern technique is used to solve non-linear and non-differentiable optimization problems that traditional methods cannot handle (Rajguru and Mahatme, 2015).

The emergence of artificial intelligence (AI) techniques as another optimization technique further advanced the quest to tackle the various associated odds of other MCMD techniques. The classical Technique for Order Preference by Similarity to Ideal Solutions (TOPSIS), for example, and other methods in this group, such as artificial neural networks (ANN), the Analytic Hierarchy Process (AHP), and expert systems (ES), are mainly employed in more complex optimization problem-solving approaches. Organizations predominantly aim to minimize costs, maximize profits, and deliver quality (maximizing strength and minimizing defects and rework). TOPSIS has been widely deployed in decisions and outsourcing provider selection, manufacturing decision-making, financial performance analysis, service quality assessment, strategy evaluation, critical mission planning, etc. (Chakraborty, 2022). Some classical methods, such as the TOPSIS method, were now modified. This study will prefer composite choice techniques of sorts.

##### *3.2.1.1 TOPSIS Technique: Classical and modified*

Hwang and Yoon formulated the TOPSIS model in 1981 (Hwang and Yoon, 1981).Summarily, the TOPSIS, among all the MCDM methods, stands out due to its prominent simplicity, rationality, comprehensibility, good computational efficiency, and underlying concept that the best solution is the one closest to the positive ideal solution and furthest from the negative ideal solution (Roszkowska, 2011; Parida, 2019; Yoon, 1980; Rejab et al., 2021).

The modified TOPSIS, a record enhancement and version of TOPSIS, was also created with the entropy-based objective weight elicitation procedure based on Shannon's entropy theory and the notion that subjective evaluations can be systematically quantified, and the attribute weight applied differently as in the TOPSIS (Chakraborty, 2021; Shannon, 1948; Deng and Willis, 2000). It was developed to enhance some of the TOPSIS advantages, such as the entropy-based objective weight elicitation process, and to tackle some of the bottlenecks of the classical TOPSIS; therefore, it is preferred to solve MCDM problems. The modified TOPSIS (preferred) here will henceforth be used interchangeably with classical TOPSIS simply as TOPSIS. The modified TOPSIS, beyond the other areas of deployment in the classical, eminently features in comparative studies for attribute weight estimations and development of objective composite index development and other method development

(Chakraborty, 2022).

### *3.2.1.2 Analytic Hierarchy Process (AHP) technique*

Myres and Alpert initially introduced AHP in 1968, and Saaty improved it as a model in 1977 before applying it to difficult decision issues. AHP helps identify the most befitting alternative needed to formulate a combination of hierarchical structures, including targets, main criteria, sub-criteria, and alternatives, also jointly evaluating them in quantitative and qualitative criteria terms (Girginer, 2008).

Generally, AHP, like any other (MCDM) technique, has the advantage of assessing criteria variety with different units. This is a highly valued advantage over traditional decision-making methods requiring converting all the requirements to the same unit. It may also evaluate both quantitative and qualitative criteria simultaneously (Bozbura et al., 2007). Vatansever and Kazançoğlu (2014) posited that AHP, as mostly a measurement theory, is the most comprehensive application used in multi-criteria decision-making, planning, resource allocation, and solution of problems.

### *3.2.1.3 Hybrid of modified TOPSIS and AHP*

In the study by Ince et al., (2017), the AHP-TOPSIS method was combined to prevent difficulties and time waste in the e-content-producing process. This hybrid AHP-TOPSIS method was reliable as the drawbacks of the otherwise individual method were eliminated and the results demonstrated the method's importance.

Though AHP inherently has the advantage of the combination of factors of hierarchical structure Girginer, (2008) over TOPSIS, however, Ince et al (2017) posited that TOPSIS usually have the overall added advantage of better distribution of calculated points as well as having uniformly distinguishable points than AHP. TOPSIS simplifies the decision-making process, helping decision-makers manage multiple problems and apply governance policies effectively in all aspects related to scientific research (El-Mohadab et al. 2019). Therefore, the TOPSIS method could be the best performance for evaluation. Better still, the hybrid of AHP and modified TOPSIS are usually complementary in terms of solutions to the deficiency of each other, characteristically. However, the main shortcoming of this composite MCDM procedure method is the impact of the uncertainty on decision criteria. Therefore, for an acceptable, balanced, and accurate configuration output, care is taken to ascertain subjective and objective weighting methods are effectively complementary in functionality (Yu et al., 2009).

Since the Analytic Hierarchy Process (AHP) could solve the problem of biased weighting factor according to the study analysis presented by Kalbar et al. (2012), this MCDM research work, therefore, proposed the deployment of such hybrid weighting methods which combines subjective weighting method (AHP) and objective weighting method (TOPSIS). Consequently, in this research, the composite Techniques of TOPSIS and AHP optimization methods will be adopted for analysis

TOPSIS, besides the other advantages, Kalbar et al., (2012), highlighted that it was preferred over other approaches because of (i) its appropriateness for the large number of characteristics and alternatives; (ii) its necessity for minimal subjective input; (iii) its coherent and programmable nature and; (iv) ) the ranking of alternatives consistency (Kalbar et al., 2012).

The intended MCDM adopted will be a composite MCDM procedure: the modified TOPSIS and AHP algorithms. The modified TOPSIS-AHP composite procedure was preferred and accepted for the MCDM analysis in order to have more realistic criteria weighting factors (Ukoba et al., 2020).

TOPSIS is the most popular multi-criteria decision-analysis technique because of the outlined benefits. The process for determining the weights and assessing the decision-makers' consistency nevertheless, is the primary drawback of the approach (Borawska 2014)

### *3.3 Summary of literature for knowledge gap analysis*

In the past, research work had been expended on the subject matter by researchers in tackling the menace of cost overruns and quality non-conformances. A number of the researchers, painstakingly, identified and chronicled about 70 associated variables/ criteria, derived from a comprehensive literature review such as corruption, security, Financial insolvencies by contractor, Poor contractor experience exhibited in construction errors, Ineffective planning and coordination of work activities, Low productivity of labour, Inadequate staffing, Weak motivation etc. (Niazi & Painting, 2017; Getaneh & Kansal, 2022).

 

Table 3.2 - A summary of the literature showing grouped alternatives with considered causes/criteria

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| **Client/ Consultant related:**<br>- Frequent change orders and delays throughout the project cycle<br>- Poor financial control mechanism<br>- Incompetence and inexperience exhibited in construction errors | **Risk/ External related:**<br>- Corruption<br>- Security Issues<br>- Conflict management and delays among team/stakeholders<br>- General uncertainties |
| **Material and Equipment Related:**<br>- Procurement delays<br>- Sustainable technical equipment challenges<br>- Materials/equipment poor handling and substandard usage | **Contractor related**: (Niazi & Painting, 2017; Getaneh & Kansal, 2022)<br>- Financial insolvencies by contractor<br>- Poor contractor experience exhibited in construction errors<br>- Ineffective planning and coordination of work activities |
| **Labour related**: (Niazi & Painting, 2017; Getaneh & Kansal, 2022)<br>- Low productivity of labour<br>- Inadequate staffing<br>- Weak motivation | **Procedure and Control Related:**<br>- Poor Planning<br>- Poor execution projections and documentations<br>- Procedure implementations and controls |

From the above, those have contributed severally, in one way or another, in sustaining the problem to date. No matter the severity of the damage or negativity in those contributions, the solution is not to wish them away. Rather, the solution remains with the management executive figuring out strategies to optimizing the contribution: the integration approach must be controlling, monitoring and regulating since as inherent components of the optimization challenge, they may not be necessarily eliminated in the project system. A number of these contributing factors could be collapsed into characteristic groups to make it manageable in the mitigation approach. Some of the researchers had gone even much deeper in subjecting the factors to critical assessment to rank their contributing impact to the functional objective targeted cost and quality optimization.

### *3.3.1 Current advances*

Many scholars, from the referenced literature, have deployed concerted intellectual energies delving into the construction site challenges of sorts as solution providers. Although they are yet to make the possible ‘fit for all magic wand’ breakthrough, there have been many plausible and progressive results. Their impactful determinations had contributed immensely in the areas of: critical components analysis of project cost management; key critical factors causing the Construction Industry overruns; the use of hybrid AHP-TOPSIS method for MCDM Evaluation and selection; demonstration of how a project’s quality performance can be improved upon by focusing on critical cost management elements; strategies in the best practices for effective cost management and performance evaluation; the perceptions of ranking of the severity using relative importance index of the various factors; multi stakeholders’ perspective of causes and impact analysis of cost overruns in subsea oil and gas projects; the significant risks faced by project managers in oil and gas construction; the relationship between unethical tendering practices and cost performance of projects; the allocation of resources and labour, that meets a certain quality output, in time and within budget and contractual obligations; the construct of stakeholder engagement and various other full potentials of stakeholder engagement; efficient deployment of the various tools and techniques in project construction management for optimal cost performance mix etc.

### *3.3.2 Future direction*

Instructively, many of the target research works had recorded breakthroughs and improvements are still being made to tackle the conflicting constraints exhibited in cost and quality optimization on the management of construction sites, most importantly. World over, the contributions of construction to the GDPs of nations’ economic power had been acknowledged, more to the economy of the privileged oil and gas-rich nations. So there is no relenting in doing more studies.

Most research works have recorded positive results in meeting the research objectives. Over the years, there has been continual sustainable streamlining of the enormous challenges the construction industry faces. A few picks from my references in this work showed that many of the major findings and intervention strategies in this related study had made some landmark accomplishments in mitigating cost overruns and quality non-conformances. However, there are still some grounds to be covered.

Many novels and improved work has been done in multi-tier stakeholder engagement and influence, skilled personnel competence, equipment and machinery qualifications, governance system, proper risk identification and management, maintenance and calibrations, conformities to standard and specifications requirements, informed and not optimistic cost estimating, etc., have been identified and are quite strategic, characteristically.

*3.3.3 Synthesis for future work*

The knowledge gap remains a concern in optimizing the factors (constraints and variables), individually or in combinations, regarding the enormity and criticality of the impact on optimization schemes in the oil and gas construction sites. Consequently, the objective function of the cost and quality optimization solution must be monitored, controlled, and delivered within acceptable limits. Those limits must, in turn, be defined and subjected within the boundaries of the project risks, HR, scope, time, safety, stakeholders, project manager capacity (skill and experience), time, etc. They are feasible solutions out of a large pool of conflicting constraints and decision criteria, where the optimal problem can be modeled in terms of an arbitrary feasible framework of management values. Some of the identified decision-making variables worth improving upon, from the existing literature, include governance, corruption, personnel competence level, conflict of interest, risk management evaluation, and stakeholders' expectations.

This study will summarily dwell on adding to the body of knowledge, from the existing limited literature: the most appropriate/effective way of mitigating conflict of interest especially from top-ranking management executives; is a determined effort to stop the compromising of the designed quality expectations at the expense of cost saving to the footing of personal interests (which eventually escalates cost overruns); aiding the project manager to develop a comprehensive control mechanism for the team (especially the management team) for transparent team players' attitude, disposition and development of a viable optimization evaluation model.

Depending on the criterion and time, the cost and product quality are impacted to various degrees. According to Sullivan and Artino (2013), for computer simulation purposes, the several degrees of impact assessment are categorized using the 5-point Likert scale assessment of qualitative criteria, which represents the level of impact it would exert on the probable criterion breach when it happens in a project under construction. The result is further synthesized using the composite modified TOPSIS/AHP optimization techniques for decision-making analysis.

## 4.0 Conclusions

This paper has practically explored all the previous pertinent literature on construction site management, especially in the oil and gas sector for knowledge-based cost and quality optimization. Painstakingly, it reviewed effective construction site works that embraced objectivity and considered all the criteria against optimal quality and cost mix. This paper outlined all the sustainable planning, monitoring, and controlling activities and sub-activities before, during, and after construction site works. It also carried out the knowledge gap analysis and revealed some areas of improvement within the study framework.

Some of the research questions that need to be addressed in future works include: Why is project success delivery still elusive in most projects despite the emphasis on focal objectivity of optimizing cost and quality, for example, in a construction site project?

Despite implementing stringent and rigorous recruitment procedures to assess professional project managers' ethical values and skills before their engagement, why is there still a prevalence of unsuccessful projects? Could they be attributed to recruitment gaps or errors in the selections?

With the technological advancement in artificial intelligence and the progress in the project management process, why is it still challenging, in practical terms, to have a comprehensive project management model for construction site works?

In the future, optimization works of cost and quality in the oil and gas construction sites could basically be anchored on a modified framework of a hybrid MCDM algorithm scheme. Can it be identified?

With this review, quite a significant contribution to the body of knowledge of cost and quality optimization is made in terms of inspection, informed in place of optimistic cost estimates, detailed understanding of the scope and thorough risk management analysis and management, all-encompassing but stringent quality assurance and strict adherence to the specified quality control management options together with comprehensive documentation (collation of procedures, plans and as-built records, audits and lessons learnt and other reports), and the quality benchmarking of all the activities on site against these major groupings: manpower, materials, machinery and methods requirements.

The project manager and his team must be focused, proactively renege from personal conflicts of interest at the expense of the corporate organization, and eschew integrity crises such as corruption of sorts and sharp practices. The stakeholders rely on the team to meet their expectations.

For proper and successful project delivery, the optimal balance of cost and quality with the proper mix of the various project criteria results in achieving the core project objectives and expectation.

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