



# Critical Factors to Overcome Project Scope Creep in the Oil and Gas Industry: Analytic Hierarchy Process Approach

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## ABSTRACT

This study aims to determine procurement and project management critical factors to develop procurement strategy with stakeholders to eliminate project scope creep (PSC) risks in the oil and gas (O&G) sector. Analytical hierarchy process (AHP) methodology is applied to prioritize the critical factors from tendering management (TM), contract quality (CQ), and project management (PM) criteria to solve the PSC problem. Data are from eight managerial levels and two specialists from procurement and project departments of two O&G companies in the UAE context. The study revealed that there are six factors out of 15 that are critical factors from procurement management: 1) tender strategy, 2) tender clarifications meetings and negotiation, 3) tender document preparation, 4) techno-commercial bids evaluation and award, 5) well-written contracts, and 6) supplier selection criteria. This study provides managers with tools and strategies for successful project management practices in the UAE.

## KEYWORDS

Analytical Hierarchy Process, Contract Quality, Contract Management, Oil and Gas Sector, Procurement Management, Project Management, Project Scope Creep, Tender Strategy, Tendering Management, UAE

## 1. INTRODUCTION

The oil and gas sector plays a crucial role in today's and future global energy-mix economy (OGUK, 2019). The oil and gas industry is one of the most significant industries globally in terms of projects, including operations and maintenance costs activities (Sylvester et al., 2011). In addition, these projects are characterized by the highest complexity, competition, and criticality to any country or organization around the globe (Hasan & Alhashimi, 2019). Additionally, the oil and gas industry faces several challenges during project execution to comply with the PM triangle elements: cost, time, and scope/quality/ reliability (Sefair et al., 2017). As per the Chartered Institute of Building Surveys (CIBS), 81% of oil and gas projects and 42% of engineering projects were delayed in 2013 due to PSC (Parker & Cullen, 2015). Also, Parker & Cullen (2015) states that more than 600 projects got 85% failure of government and not-for-profit projects in several countries due to PSC. PSC phenomenon is extensively

faced during the O&G project execution phase. PSC is defined as an increase in deliverables without increasing project resources or timelines (Abbasi et al., 2014; Siriram, 2019).

Accordingly, there is a need to understand procurement management-related activities (Tendering Management (TM) and CQ) key factors and Project Management (PM) critical factors to design a procurement or project strategy eliminating PSC. PSC has two main dimensions. Firstly, PSC is the uncontrolled reality of project environments as external factors (Ajmal et al., 2019; Sindi, 2018). Secondly, it can be controlled internally by procurement management. It includes managing all strategic, operational planning, policies & procedures, coordination, and decision-making related to purchasing activities of the procurement unit. Its main functions are purchasing / TM and sourcing management/ CQ (Becit & Görener, 2019).

The main reasons for PSC are due to unawareness of one side of stakeholders with changes in project requirement during the project management (PM) stage, no agreements among stakeholders or main two parties of a contract, and no risk taker, no assessment or acceptance of responsibilities of potential impacts among them (Amoatey & Anson, 2017).

Scope changes do not always become PSC, but a readiness of project scope to control such changes can lead to a project's performance (Kagogo & Steyn, 2019). Also, we need to strategize all our requirements, resources, and plans by taking the right decision at the right time at the right place to involve in the early stage of the project (TM stage), middle stage (CQ), and during it (PM stage). The objectives of this research are twofold:

1. Identify the critical factors that eliminate the PSC in the UAE oil and gas industry project's three stages.
2. Prioritizing and measuring the importance of all procurement and project management critical factors by using Analytical Hierarchy Process (AHP) model to overcome the problem of scope creep in the oil and gas sector.

These objectives will bridge the gap of knowledge in literature about PSC and the key factors that manage such issues. In addition, there is also a lack of a comprehensive AHP framework in the O&G sector in the UAE context to resolve the PSC issue and support leaders and decision-makers to strategize and conceptualize their resources towards the problem solving of such issues a variety of ongoing and upcoming projects.

This AHP paper is divided into five sections: first, the literature review consists of two main subsections: the problem of PSC and the critical factors in the three dimensions of TM, CQ, and PM that are a solution. Second, the methodology section is based on literature findings, and it develops the conceptual research framework, data collection, and AHP analysis method. Third, the results section analyses the collected data from a 1 to 9 scale based questionnaire using AHP. Fourth, the discussion section critically examines the results, such as pairwise comparisons relating to the main and sub-criteria determining the critical factors that overcome the issue of PSC. Finally, The conclusion section summarizes the paper, original contributions, managerial and theoretical implications, limitations, and future research.

## **2. LITERATURE REVIEW**

### **2.1 Project Scope Creep in Oil and Gas Industry**

All types of projects can be found in the oil and gas industry, like operational and maintenance projects such as construction, consultancy, and IT projects. This industry also has a variety of turnkey and significant engineering, procurement, and construction (EPC) projects. All those project types are common in project success to achieve the iron triangle factors of scope, time, and cost (Galli, 2021).

The conceptual misunderstanding between scope creep and scope change is commonly made by most people as changes are not necessarily scope creep (Amoatey & Anson, 2017). As per Amoatey & Anson (2017), the agreed changes between client and contractor are impacted in projects' scope, cost, and schedule, either compensated or not to the contractor. Scope creep a change in a project in which either one of two parties (client and contractor) is not aware of these changes or no agreements between both, or no review or acceptance of potential project impacts (Goswami & Behera, 2021). As per practitioners, the leading causes for PSC are due to client changes, unclear scope, and unforeseen potential risks. Hence, there is a requirement for a mechanism to establish strategic and critical factors to help the decision-makers in oil and gas companies for quick and accurate decisions (Goswami & Behera, 2021).

## **2.2 Factors for Overcoming Project Scope Creep in Oil and Gas**

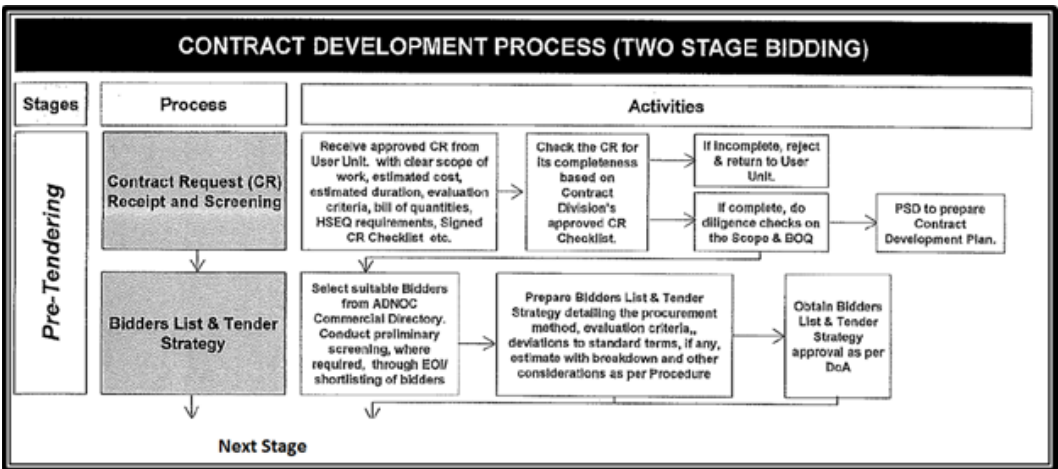
### **2.2.1 Tendering Management**

In the oil and gas industry, the initial stage of any project starts with tendering activities then contracts development before actual project initiation. It means before managing any project, there is a need to manage the tendering activities. TM is all activities related to develop and produce a high-quality contract and reducing the scope creep by clarifying the project requirements (Kelly et al., 2021). Firstly, in the pre-tendering stage, the contract professional shall-upon receiving a project contract request- start reviewing the project request and preparing the tendering strategy or planning as per Figure 1A. It means preparing project marketing and strategic planning to let the project cope against any unforeseen environment during PM (Galli et al., 2021). A tendering/bidding strategy can be defined as the framework of the tendering process, tendering methods (one stage of submitting both technical and commercial bids, and two stages bidding to submit technical and the commercial bid), tendering timing and award of tender; i.e., single award or split award (Eba, 2014). Adedokun et al. (2013) agreed with Eba (2014) and added that tender cost estimate (i.e., estimated project price results of estimator works), number of bidders/suppliers; i.e., sole-source (unique brand) or competitive restricted tendering for particular nature oil and gas industry and works or unrestricted or public tendering (Adedokun et al., 2013b). Furthermore, the tendering strategy includes techno-commercial evaluation criteria (how to evaluate the bidders) and allocated budget from the previous and current year and project's scope of works/services-description plus any related specifications and drawings; this procurement strategy includes early supplier engagement to coordinate with client and procurement specialist if needed to estimate all specific project plan including predicted risks according to collaborated parties experience (Naoum & Egbu, 2016). As per Naoum & Egbu (2016), such activities ignite lean project activities platform.

As a part of quality management, oil and gas companies' clients challenge the potential bidders against the minimum quality standards before select those for a bid (Sylvester et al., 2011). It ensures selecting the eligible bidders to be engaged in the potential tender, contract, and project to overcome PSC. In addition, clients sometimes engage the main contractor as the third party to select the qualified supplier or prepare selection criteria to ensure quality competed for bids (technical and commercial) submission during tendering stage (Martinsuo & Sariola, 2015). As shown in Figure 1B below per procurement and project expert, this stage starts with preparing tender documents and issuing Request for Tender (RFT) invitation correspondence to the approved bidders. Such invitation includes Scope of Works (SOW), Bill of Quantities (BOQ), specifications/drawings, terms & conditions, Technical Evaluation Criteria with a cutoff score, instructions to bid, tender submission closing date for technical bid, etc. and all are parts of tender document. Sometimes the contracts business unit (CBU) receive clarification requests (e.g., Contractual/technical/commercial (non-priced format) /legal, etc.) from bidders, the CBU team response to those clarifications as tender bulletins fax to all bidders after liaising with the technical user unit, legal advisor unit, etc. or directly (ADNOC Refining, 2019). Also, Agarchand & Laishram (2017) state that is standardizing bid documents, including RFT form

and other correspondences aiding the quality of contract content and later ensuring the quality of a project outcome (Agarchand & Laishram, 2017).

Figure 1(a) Pre-Tendering Stage- Starting with CR Receipt



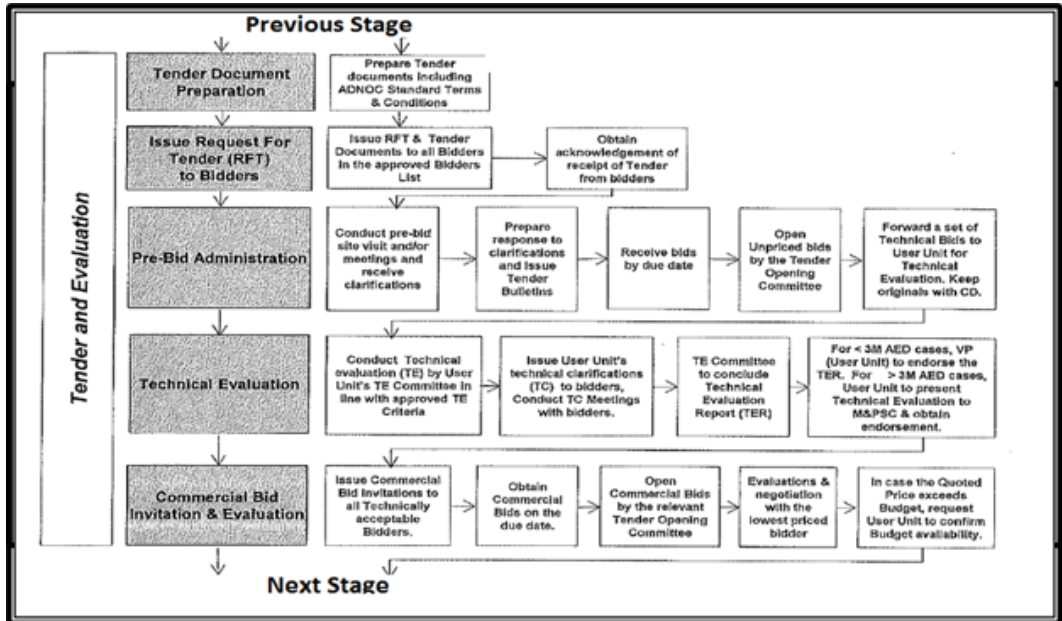
It is mandatory to meet with potential project stakeholders, including clients, main contractors, subcontractors, and any third party pre of tendering stage and during negotiations, to overcome scope creeps during project execution due to any misunderstanding of project requirements (Nevstad et al., 2018). Sometimes, suppose there is a need to visit the site to clarify the scope of the anticipated project. In that case, the CBU will arrange a pre-bid meeting with all the bidders to have a familiarity with the site and tender requirements (ADNOC Refining, 2019).

On the bid closing date, Technical Bids from Bidders will be received and opened by the un-priced Tender Opening Committee and forwarded to the user unit to evaluate un-priced bids (ADNOC Refining, 2016). The Technical Clarifications (TC) will be received from the user team (if applicable) and forwarded to bidders to arrange TC meetings with Bidders if required. After the meeting, the received TC responses from Bidders will be forwarded to the user. As per the Delegation of Authorities (DOA), the issuance of Technical Evaluation Report (TER) for tenders with estimates higher than the specified limit (for example, AED 7 million authority of O&G company's CEO), TER shall be presented to the special Projects Steering Committee (PSC) by the user for obtaining PSC endorsement for TER (ADNOC Refining, 2019).

After that, priced bid invitations to technically acceptable Bidders will be issued, receiving priced bids and arrange to open by the Priced Tender Opening Committee (PTOC) (ADNOC Refining, 2019). The CBU will carry out commercial evaluation and issue commercial clarification to Bidders, if required, to receive revised priced bids (ADNOC Refining, 2019). The negotiation team is formed from the VP/manager as a team leader, contracts section head, the contracts engineer who is handling the tender and user representatives, the price negotiation meeting with the lowest bidder to achieve maximum saving as per the tender estimate and the approved budget, the revised priced bid will be obtained subsequently and opened by a manager of CBU (ADNOC Refining, 2019). Lahdenperä (2016) agrees with these process steps to establish specified and customized technical and commercial bid criteria that suit the current tendering project to overcome scope creep after awarding the contract. In some cases, awarding criterion to the lowest priced technical accepted bidder might lead to the risk of scope creep due to cost overrun risk after winning competitive tender by quoting the lowest priced bid for the sake of tender winning only (Lahdenperä, 2016). They suggest adding incentive to

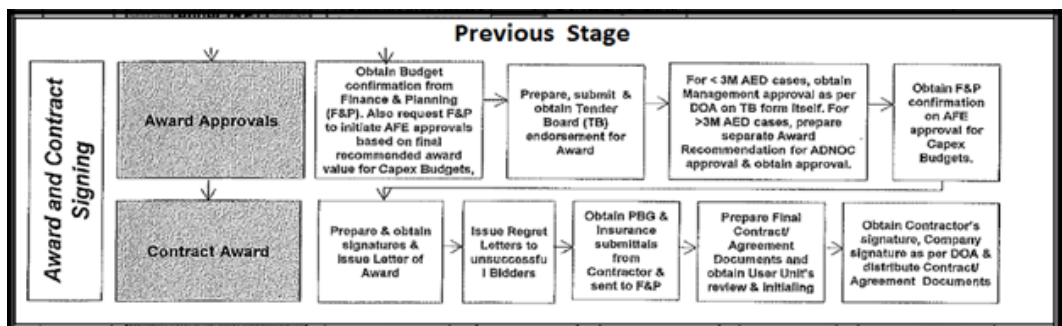
those who quote within budget or project estimate through two stages bidding mechanism, but this solution has not been tested empirically yet.

Figure 1(b) Tendering Stage- Starting with Tender Document Preparation



In awarding stage (Figure 1C) is to prepare award recommendation in favor of the lowest technically acceptable bidder and submit it to the tender board for its endorsement and subsequently for approval as per the DOA, but this after extensive preparation, review, and compilation of the submission report by CBU team (ADNOC Refining, 2019). In some cases, in addition to the lowest-priced bid or offer, in the UAE, the oil and gas company requests to award the tender to the highest in-country value (ICV) contributions to the local market in terms of utilizing local materials and resources, building local facilities especially for overseas companies, Emiratisations or employing locals, etc.

Figure 1(c) Awarding & Signing Contracts Stage- Development of Contract Document



As per the literature mentioned above, the TM criteria have several sub-criteria: tendering strategy, tender strategy, supplier selection criteria, tendering documents preparation, and technical & commercial bid evaluation and award. In addition to that, all the tenders' clarifications & negotiation meetings' correspondences, such as minutes of meetings, faxes, emails, etc., are to be included in a contract to mitigate the risk of scope creep in the future project initiation.

### 2.2.2 Contracts Quality

A contract is an agreement between two or more parties that creates responsibilities for each party to perform something or promises (e.g., such as building a bridge project at a specific scope, price, and schedule of time), and this agreement comes into force by a court of law, which means in case one part dishonor the contract the other party has the right to bring an action for damage in the court or to go for arbitration to keep the confidentiality of the contract and to maintain the long relationship of business parties (Kujala et al., 2015). The commercial satisfaction of a contractual relationship needs a contract to be in writing; this formality leads to a written or other permanent records (such as E-contract) or what has been agreed, and this enables third parties (including the courts) to see what rights and duties under the agreement affect each party (Trad, 2021; Tripathy & Mishra, 2017). Also, the reasons for formal/written contractual relationships are inaccurate memory (i.e., People forgets), no trust between/among parties, and complexity in technical/commercial/legal issues (AZTech & COPEX, 2014). According to the definition of the contract, we can determine the main elements of any contract as follows:

- Offer (technical & commercial bids submitted by bidder/potential contractor)
- Client acceptance through awarding the tender
- Agreement's certainty Terms
- Consideration (sometimes)
- The intention of creating a legal relationship
- Formality (writing, sealing, registration, and so on)

These elements of a contract and its formalities differ from country to country and according to the type of law or jurisdiction of this law (AZTech & COPEX, 2014). The probability of scope creeps occurrence measures the CQ during the phase of execution of the project. The scope creep is an uncontrolled change to a product or original scope of a project beyond its agreed time, cost, and resources in a contract or project charter; i.e., scope creep is an effect of scope change without adjustments to time, cost, and resources (The Project Management Institute Inc., 2013). Any project manager usually faces this issue that deals with excessive and verbal demands from the client to expand the original project scope (Costantini et al., 2021). The adjustments to the original scope are not necessarily damaging if the change in scope of work is handled and documented correctly (Costantini et al., 2021). Costantini et al. (2021) agree with (Bellenger 2003) that the possible causes or factors of scope creep are a lack of communication between the parties involved (E.g., client, contractor & sub-contractor), a lack of understanding/analysis of the original scope of work, firms' failure to utilize proper contract procedures & its manager's ego or desire to increase revenue, failure to establish and comply with internal procedures for dealing with change orders and clients seek to get more work out of the firm/contractor for free (Bellenger, 2003).

According to Costantini et al. (2021), it is to be noted that the damaging effects of scope creep can be managed and limited by following few simple guidelines such as proper communication/ business negotiations and contract procedures or documents. Every job will require some squeezes to the original scope of work, which means you cannot eliminate changes to the project scope. Still, it can manage its effect through proper communication/business negotiations and contract procedures. Contractors and clients should explicitly mention their scope of works & services in the project contract, along with exclusion or responsibilities (Al-Batayneh et al., 2021; Baporikar,

2017). According to Kujala et al. (2015), this should be outlined at the initial kick-off meeting as referred to in a contract, including any subcontractors involved in the project and their work should be established. Changes to the project's scope should be treated as an entirely new contract with the client or, in other cases, a variation to the main scope (Kujala et al., 2015).

It means the contractor should fully understand the scope of the new assignment, confirm it with the client, and put it in writing (Andersen et al., 2016). For clarity in roles & responsibilities, negotiation should be conducted between parties for any change in scope of work during tendering or contract documents compilation (Sarmiento & Renneboog, 2016). All of Andersen et al. (2016), Costantini et al. (2021), Kujala et al. (2015), and Sarmiento & Renneboog (2016) agreed that scope creeps elimination can be done through proper channels of communication, including negotiation and proper contract documentation of project scope and all other project's correspondences. It is recommended to have third-party draft contract documents for two parties (i.e., the client and service provider) to focus on mitigating the project's risks in the future and after signing a contract (Sarhan et al., 2017). Sarhan et al. (2017) state that is customizing each document to cope with different projects and parties' requirements and go beyond the standard fixed context of contracts 'templates.

The contractor must ensure that the scope of work is adequately defined in any contract by the client and raise any clarification during the contract's signature and in the tendering stage of the project at the first position. Scope creep sometimes resulted in undocumented verbal communications (Olsson et al., 2018). To minimize any project's risks of scope creep, any conversations concerning the scope of duties or responsibilities should be put in writing either in contracts during the pre-project execution or project execution (Olsson et al., 2018; Costantini et al., 2021) agree with Olsson and others to put all information in a well-written document to reduce potential disputes, which may lead to scope creep. Protocols need to be established to deal with expanding work scopes (Costantini et al., 2021). Before the project outline begins to change, have a standard protocol set up to accept, confirm and memorialize changes to the scope of work (Lappi & Aaltonen, 2017). Also, Lappi & Aaltonen (2017) agreed with the previous researchers that the easiest way to deal with an expansion of work is to create supplements or variation documents to your existing contracts during the execution of a project, which should spell out the expanded scope of work as well as payment terms and conditions. It should be signed by both parties and should establish rights and remedies.

There are two main pricing models, which are Fixed Time Fixed Price (FTFP) and Time & Material (T&M); the other models are simply variations of these two main categories (Jain & Khurana, 2015; Wheatcroft et al., 2021). Those are studied in terms of the general specification of each Contract's pricing model and how each one handles the Scope Creep (Jain & Khurana, 2015). In FTFP, the client and contractor agree on a total contract price & time for the final delivery of services, products, and applications before executing a project (Wheatcroft et al., 2021). Also, failures of completing the requirements or loosely worded drafting (i.e., missing specifications or misunderstanding of requirements) are mostly the case in the fixed-priced model. Such miscommunication during the business negotiation or tendering stage can lead to incomplete documented requirements in a contract. As a result, a scope change and scope creep may occur during the project execution stage (Jain & Khurana, 2015). As all requirements are frozen in FTFP from the beginning and estimation, and the project schedule is prepared, any increase in the requirement is treated as scope creep and estimated separately (Wheatcroft et al., 2021). Accordingly, the FTFP model involves a lot of negotiation activities between client and vendor during the tendering stage and scope creeps or requirements gaps (Jain & Khurana, 2015). The business negotiation of scope creep can stress the business relationship between client & Contractor as the client is trying to add all the missing requirements within the agreed price.

In contrast, the Contractor is forced to maintain quality to compromise on quality under the pressure of meeting the fixed time frame (Al Nasser & Aulin, 2016). The scope creeps can be mitigated by including special provisions for handling the scope creeps in the contract (Al Nasser & Aulin, 2016). These FTFP contracts require a lot of monitoring and control during tendering

and project stages; the client should monitor each milestone time interval execution and request for actual/test demonstration of each milestone application/scope for meeting the agreed requirements (Wheatcroft et al., 2021).

On the other hand, the T&M contract model is more flexible than the FTFP model; it allows for changing requirements and enhancements (Wheatcroft et al., 2021). Such contracts' pricing model details the unit rates (i.e., hourly or monthly) as per employee, material, product, service, application, etc. Thus, the billing is completed as per negotiated unit rate, contractor's team skills, and devoted time to finish the work. Typically, the Contractor can claim overtime at an hourly rate if it is adequately justified. This contract module delivers the scope in units of delivery or segments (Jain & Khurana, 2015). These T&M projects do not require complete clarity on the scope as the quantum of works that unforeseen, which will be provided to the Contractor in due time of execution of the project (Al Nasser & Aulin, 2016). So, it is the responsibility of clients to monitor the scope, keep the Contractor's staff busy, and avoid billing with no efforts made by the contractor's relaxed team (Jain & Khurana, 2015). Regular communication & business negotiation between the two parties for clarification on the scope during the tendering stage will reduce the chance of scope creep and good PM and scope change management (Wheatcroft et al., 2021).

Song et al. (2018) state that flexible terms and conditions mentioned in a contract can add value to project execution. During an emergency or prompt action to an abnormal project situation, such flexibility can encourage a cooperation relationship between owners and contractors, which overcome any chance of scope creep occurrence (Song et al., 2018). Such terms and conditions are a project execution protocol and organization, dispute settlement, payment, the scope of works changes, and so on (Song et al., 2018). The project scope stated in a contract should mention project deliverables, coordination among parties and sub-parties, time, cost, and other specific project details (Aagaard et al., 2015). Pre-project strategy and client's project requirements schedule and cost are anticipated by a contractor in technical and commercial bids documents to be part of a contract to overcome scope creep (Turner et al., 2019).

From above, the CQ criteria result from the integration of pre-and post-award phases (TM and project management/execution activities). It has five sub-criteria: final integration scope after tendering clarifications, bids document, terms & conditions in each template of contracts, and well-written contract. Finally, what deserves to be added as per expert experience and the view is all correspondences during tender clarifications that enhance the clarity of the contract and the flexibility of the clear terms & conditions that give a space to add all the correspondences during the project management.

### **2.2.3 Project Management**

A project is a set of activities oriented to achieve specific goals and objectives of creating a unique product, service, or ability to perform it, and enhancement of a product and a finding or a result or document that constrained by determining time, cost, defined scope, quality, resources, risks and so on, and sometimes the project can be terminated if there are obstacles to fulfill its goals and objectives (Turner et al., 2019). An oil and gas sector project is related to outsourcing operations, maintenance, and EPC works or/and services within the oil and gas organization (ADNOC Refining, 2019). PM is a successive five cycles phase: project initiation, project planning, project monitoring & controlling project closeout, and lessons learned (The Project Management Institute Inc., 2013). It is simply the application of a project manager/ contract administrator's knowledge, skills, tools, and techniques of project activities to meet project stakeholder requirements (Galli, 2019).

As per (The Project Management Institute, Inc., 2013), phase 1 is a project initiation, and it is a process of defining the project scope, project manager, stakeholders including skilled team, and financial committed resources as per the signed contract to get approval to begin the project (Ajmal et al., 2021). The right start is by establishing a project charter during this phase to reduce the choice of occurrence of scope creep through defining the project scope and identifying parties involved in the



project (Naoum & Egbu, 2016). This project charter eliminates the causes of PSC due to no agreement among stakeholders and unclarity of the defined scope (Amoatey & Anson, 2017). Phase 2 plans the project scope, schedule, budgets & cost, and all resources related to it through work breakdown structure or milestones (Yeom et al., 2018). Especially for the mega project, there is a massive need to divide it into sub-projects and sub plans to control it and overcome PSC (Yeom et al., 2018).

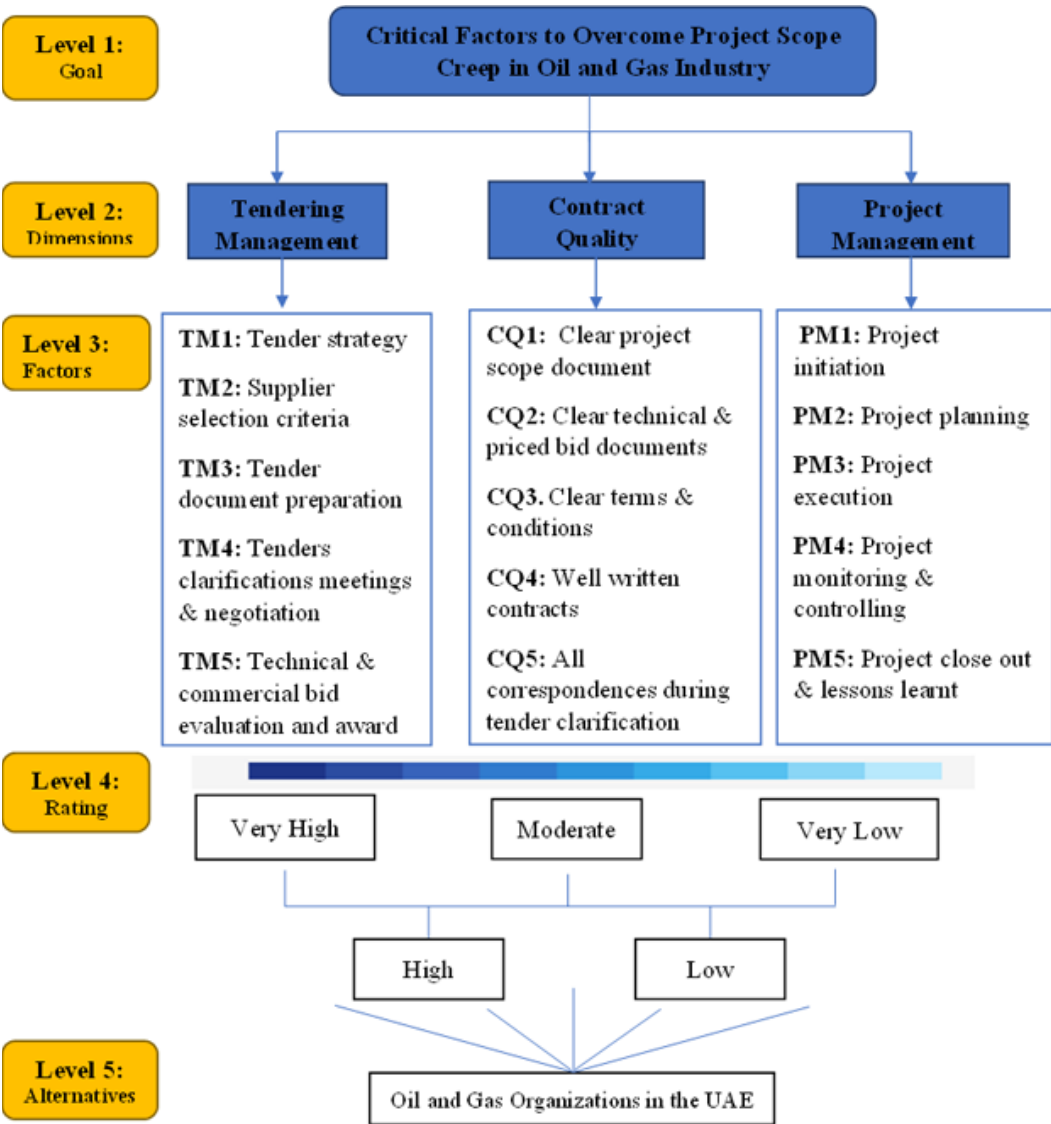
In some cases, project planning cannot be predicted unprogrammable events such as project crisis and crisis management planning to be programmed as a project protocol to overcome scope creep occurrence (Kagogo & Steyn, 2019). Such a protocol will be described in detail in the project contract or planning from those mentioned above. Project execution is the third phase of PM, and it is defined as putting the plan into action through leading and managing project works activities (The Project Management Institute, Inc., 2013). The project execution is all organization's practices and management activities adapted to all project's characteristics and phases toward completing it according to pre-defined specifications on time and cost after considering all complexity of environments that affect project quality (Rolstadås & Schiefloe, 2017). In phase 3, the project manager should be careful as any unjustified and unreasonable change might change the plan of resources in phase 2 and PSC incidence. Fortunately, any change in budget, schedule, or scope can be controlled via phase 4, i.e., control and monitoring the project (The Project Management Institute, Inc., 2013). Such control of and deficiency of the project progress monitored by the project team can be validated and corrected by change request procedures in case of significant change in the project contract through an appropriate channel, approval authorities, policies, and best practices of any organization owing this project to manage and control risks of it (Ajmal et al., 2021). Finally, phase 5 is project closeout and lessons learned, and it is completing the project by fulfilling all contractual obligations, project scope and verifying the same by all stakeholders (The Project Management Institute, Inc., 2013). Turner et al. (2019) agreed with The Project Management Institute, Inc. (2013). They added that after closing out any project, the project manager's experience and knowledge through this project and the accumulated experience of other projects affect PM success in the future and help to overcome PSC. Project management expertise is a critical asset in any organization for successful project closeout & lessons learned from it (Andersen et al., 2016). This phase reports positive feedback of a successful project closeout or negative feedback in case of project failure due to PSC to go back to phase 4 (control and monitoring of projects) or to close out the project and to educate the project teams and other project teams with all the abnormal activities about PSC in the failed project or survival project.

### 3. METHODOLOGY

As per the literature review, the main and sub-factors of procurement and PM for overcoming PSC in the O&G industry are determined. Figure 2 highlights the complexity of implementing PSC elimination via procurement and PM mechanisms in oil and gas organizations.

The first step in the AHP is to identify and define the problem (AlHashmi et al., 2021), as shown in Figure 2. The problem is the PSC in the oil and gas industry, and this research aims to identify critical factors to overcome it. Step 2 is to develop a hierarchical structure of the PSC problem, as shown in Figure 2. Figure 2 shows this research's AHP model of identifying the factors mentioned above as a goal in the first level of the model. Level 2 in the model comprises three dimensions as multi-criteria: TM, contact quality, and PM. There are five sub-criteria for each main criterion as factors totaling 15 in level 3 shown in Figure 2. Level 4 illustrates the priorities of importance for each factor. Level 5 is the critical factor resulted from the AHP evaluation process.

Figure 2 AHP model on Critical Factors Overcoming Project Scope Creep in Oil & Gas Industry



As per Saaty (2005), the questionnaire of this model was designed using a 9 – point scale, as shown in Table 1. The instrument was reviewed for content validity by five subject matter experts (one high-level management & two medium-level management in an oil and gas company and two academics) before it was tested thru Analytical Hierarchy Process (AHP).

The data is collected from eight procurement and project managers and two specialists. The AHP methodology accepts a small sample size (Saaty, 2005). In addition, the specialist had engaged in many organizational strategic and decision-making processes in the oil and gas industry.

Step 3 is to compare the importance of pairwise at a time as a judgment. Logical thinking of the accumulated long experience is the basis of each judgment (Kazibudzki & Křupka, 2019). Such pairwise comparisons generate more reliable information that improves judgment consistency (Kazibudzki & Křupka, 2019). It uses the geometric mean instead of the arithmetic mean for a

combination of each pairwise comparisons judgments and obtains overall pairwise comparison matrices (Kazibudzki & Křupka, 2019).

Table 1 The 1 to 9 scale for AHP

Intensity of importance	Definition	Explanation
1	Equal importance	Two criteria contribute equally to the objective of waste reduction
3	Moderate importance	Judgment slightly favor one over another
5	Strong importance	Judgment strongly favor one over another
7	Very strong importance	A criterion is strongly favored, and its dominance is demonstrated in practice
9	Absolute importance	Importance of one over another affirmed on the highest possible order
2,4,6,8	Intermediate values	Used to represent a compromise between the priorities listed above

As an instance for step 3, if an expert identifies that tending management (TM) has very strong importance more than PM, this means TM is rated “5” times PM is “1/5” times TM (Saaty, 2005). Table 2 shows the questionnaire and data filled with the main criteria as an example.

Table 2. The AHP questionnaire sample for the main criteria

Factor	Equal Importance 1	Weak or slight importance 2	Moderate importance 3	Moderate plus importance 4	Strong importance 5	Strong plus importance 6	Very Strong importance 7	Very, very strong importance 8	Factor
TM			3						CQ
TM					5				PM
CQ				4					PM

Step 4 synthesis starts with calculating the eigenvectors (relatives weigh), a degree of relative importance among factors that will be calculated after the pairwise comparison and matrices development (Kazibudzki & Křupka, 2019). In addition, total weight and maximum eigenvalue ( $\lambda_{\max}$ ) are calculated for each matrix (Saaty, 2005).

As per Saaty (2005), step 5 stars by calculating the Consistency Ratio (CR) of the estimated vector using the below formula to verify the consistency:

The Consistency Index (CI) is calculated for each matrix reference index  $\pi$  max value and the matrix of order in by the following formula:

The Random Index (RI) of pairwise comparisons have been simulated to give average RIs for different sized matrices, given in Table 3 (Kazibudzki & Křupka, 2019).

**Table 3. Random Index (Kazibudski & Krupka, 2019)**

N	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.48

*n* is the number of factors

The CR acceptable value for inconsistency should be £ 0.10 as per previous research. The three main criteria pairwise comparison is illustrated in table 4 using geometric analysis (Kazibudski & Krupka, 2019).

The last step is defining the overall relative priorities of criteria. Saaty (2005) calculated it by computing priority vectors (PV), as shown in the final column of Table 4. PV for each factor is calculated by using a “consistency principle.

#### 4. RESULTS

Table 4 shows that the senior expert considered the TM dimension the most important with a priority weight of 62%, followed by 28% for CQ and 10% for PM.

**Table 4. Geometric Means of Pairwise comparison of main criteria**

Criteria	TM	CQ	PM	Priority vector
TM	1.00	3.00	5.00	<b>0.62</b>
CQ	0.33	1.00	4.00	<b>0.28</b>
PM	0.20	0.25	1.00	<b>0.10</b>
<b>CR Value: 0.08 &lt; 0.10 (consistent)</b>				

Table 5 shows the pairwise comparison of the sub-criteria within each criterion was conducted using geometrical analysis, and it fulfilled the acceptable CR requirement. As shown in table1, the criterion in level 2 is divided into five sub-criteria totaling us sub-criteria. The TM’s sub-criteria are tendering strategy (TM1), supplier selection criteria (TM2), tender document preparation (TM3), tenders’ clarifications meetings & negotiation (TM4), and technical & commercial bid evaluation and award (TM5). Table 5 shows the ranting of the pairwise comparison factors, the tendering strategy (TM1) has the highest-ranking weight, 29%, and supplier selection criteria (TM2) had the lowest ranking weight, 13%. The tenders’ clarifications meeting & negotiation (TM4) had the second-ranking weight at 25%, followed by 17% for each tender document preparation (TM3) and technical & commercial bid evaluation and award (TM5). For CQ (CQ)’s five sub-criteria weight, well-written contact (CQ4) had the highest weight (35%), and the lowest weight, 10%, was all correspondences during tender clarification (CQ5). The remaining factors, clear project scope document (CQ1), clear technical & priced bid documents (CQ2), and clear terms & conditions (CQ3), ranked in the middle scoring 18% for each of CQ’s sub-criteria. In table 5 also, PM’s sub-criteria pairwise comparison was conducted, and 40% was the highest weight for project initiation (PM1) and the lowest (5%) for project execution (PM3). Project planning (PM2), project monitoring & controlling (PM4), and project closeout & lessons learned (PM5) respectfully, the weight was 25%, 21%, and 9%.

#### 5. DISCUSSION

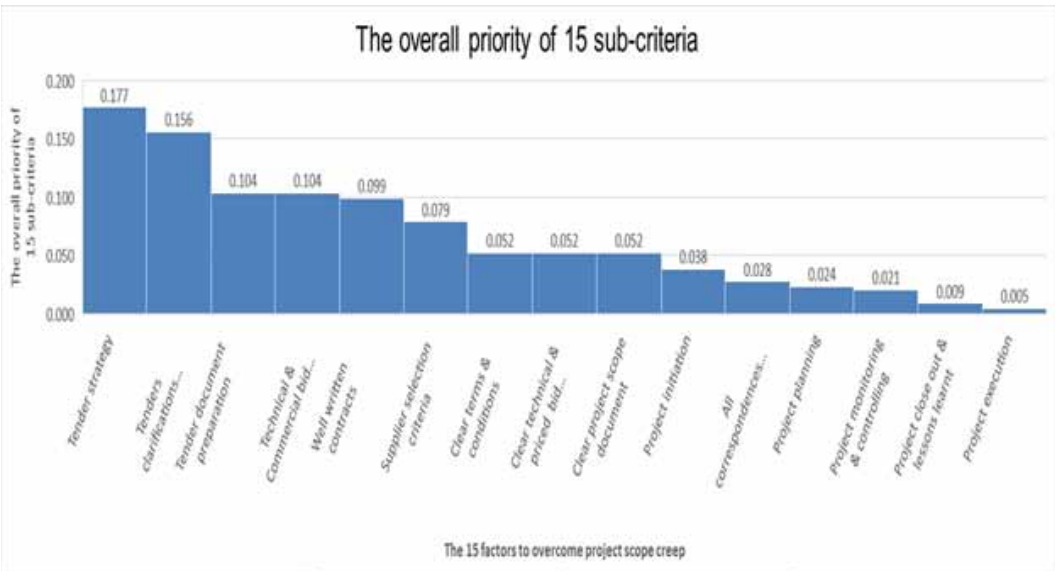
The Overall Priority Vectors (OPV) for 15 factors were calculated by multiplying the criteria priority matrix by the sub-criteria rankings (Figure 3). The tender strategy ranked the highest at 17.7%, and

the project execution lowest at 0.5%. The second-highest ranked is tender clarifications & negotiation meetings at 15.6%, followed by the third-ranked for both tender documents preparation and technical & commercial bid evaluation and award at 10.4%, fourth-ranked for well-written contracts at 9.9%, fifth-ranked for supplier selection criteria at 7.9%, sixth-ranked for each of clear terms & conditions, clear technical & priced bid document and clear project scope document at 5.2% For seventh, eighth, ninth, tenth and eleventh ranking respectively are project initiation, all correspondences during tender clarification, project planning, project monitoring & controlling, project closeout & lessons learned scoring 3.8%, 2.8%, 2.4%, 2.1%, and 0.9%.

**Table 5. Geometric means of pairwise comparison of sub-criteria**

<i>1-Sub Criteria of TM</i>							
	<i>TM1</i>	<i>TM2</i>	<i>TM3</i>	<i>TM4</i>	<i>TM5</i>	<i>Priority vector</i>	<i>Weight (%)</i>
<i>TM1. Tender strategy</i>	1.00	2.00	2.00	1.00	2.00	0.29	29
<i>TM2. Supplier selection criteria</i>	0.50	1.00	0.50	0.50	1.00	0.13	13
<i>TM3. Tender document preparation</i>	0.50	2.00	1.00	0.50	1.00	0.17	17
<i>TM4. Tenders clarifications meetings &amp; Negotiation</i>	1.00	2.00	2.00	1.00	1.00	0.25	25
<i>TM5. Technical &amp; Commercial bid evaluation and Award</i>	0.50	1.00	1.00	1.00	1.00	0.17	17
				<i>CR value: 0.03 &lt; 0.10 (consistent)</i>			
<i>2-Sub-Criteria of CQ</i>							
	<i>CQ1</i>	<i>CQ2</i>	<i>CQ3</i>	<i>CQ4</i>	<i>CQ5</i>	<i>Priority vector</i>	<i>Weight (%)</i>
<i>CQ1. Clear project scope document</i>	1.00	1.00	1.00	0.50	2.00	0.18	18
<i>CQ2. Clear technical &amp; priced bid documents</i>	1.00	1.00	1.00	0.50	2.00	0.18	18
<i>CQ3. Clear terms &amp; conditions</i>	1.00	1.00	1.00	0.50	2.00	0.18	18
<i>CQ4. Well written contracts</i>	2.00	2.00	2.00	1.00	3.00	0.35	35
<i>CQ5. All correspondences during tender clarification</i>	0.50	0.50	0.50	0.33	1.00	0.10	10
				<i>CR value: 0.00 &lt; 0.10 (consistent)</i>			
<i>3-Sub-Criteria of PM</i>							
	<i>PM1</i>	<i>PM2</i>	<i>PM3</i>	<i>PM4</i>	<i>PM5</i>	<i>Priority vector</i>	<i>Weight (%)</i>
<i>PM1. Project initiation</i>	1.00	2.00	5.00	3.00	4.00	0.40	40
<i>PM2. Project planning</i>	0.50	1.00	4.00	2.00	3.00	0.25	25
<i>PM3. Project execution</i>	0.20	0.25	1.00	0.17	0.33	0.05	5
<i>PM4. Project monitoring &amp; controlling</i>	0.33	0.50	6.00	1.00	4.00	0.21	21
<i>PM5. Project close out &amp; lessons learnt</i>	0.25	0.33	3.00	0.25	1.00	0.09	9
				<i>CR value: 0.07 &lt; 0.10 (consistent)</i>			

Figure 3 The overall priority of 15 factors



This research provides the AHP framework as a methodology to provide decision-makers insight into PSC problem-solving. The data was collected from procurement experts and PM experts with at least 13 years of experience in oil and gas. Those experts have been engaged in several actual cases of PSC in supply chain and PM, and they have occupied many managerial positions and contributed to decision making to strategize resources and solving an organization's problem. The PSC can be mitigated from different managerial aspects such as procurement management and PM. The procurement management part has two main criteria, i.e., TM and CQ/management. Firstly, in this research's outcomes, TM has the most critical priorities among the other two criteria, followed by CQ and PM. Identification and prioritization of factors to overcome the problem of PSC in the oil and gas industry was the primary goal of this research. As aforementioned, the TM dimension has 62% in overcoming the PSC, followed by the CQ dimension at 28% and then 10% for PM dimensions. This order is like what PMBOK Guideline (2013) mentioned about the project's lifecycle as it starts with the procurement phase and then the project phase (The Project Management Institute, Inc., 2013).

The literature supports the three dimensions with more focus on the contracts management and PM dimensions with less focus on TM, contradicting this research result. In the TM area, the study recommends that the decision-maker focuses on TM1: a tendering strategy that scored the highest priority of 29% and next to TM4: tenders' clarifications & negotiation meetings with 25%. These results are agreed by ADNOC Refining (2019), Agarchand & Laishram (2017), Adedokun et al. (2013), Eba (2014), Galli et al. (2021), GlobalData plc. (2019), Lahdenperä (2016), Martinsuo & Sariola (2015), Naoum & Egbu (2016), and Nevstad et al. (2018) in emphasizing the importance of tendering strategy or TM1 to overcome scope creep in the early stages of any project. The TM4 matches with ADNOC Refining (2019) and Jain & Khurana (2015). The research focuses less on TM2: supplier selection criteria with a 13% score and agrees with Martinsuo & Sariola (2015) and Sylvester et al. (2011). In the middle, both TM3 (tender document preparation) and TM5 (technical & commercial bid evaluation and award) scored 17% that also important for decision-makers. These findings are matches with researchers, i.e., Agarchand & Laishram (2017), Lahdenperä (2016), and best practices of ADNOC Refining (2019). All the five factors in Table 5 are essential to overcome the PSC. In the CQ area, the decision-makers should be aware that it is a result of the quality TM, and it can be the last precaution to PSC as it is a guideline for project steering. As per this research, the decision-

makers should focus on CQ4: written contacts of CQ have the highest weight (35%), which matches with findings of Abbasi (2014), Andersen et al. (2016), Bellenger (2003), Costantini et al. (2021), Kujala et al. (2015), Trad (2021), Tripathy (2017), Sarhan et al. (2017), and Sarmiento & Renneboog (2016). The lowest weight, 10%, was CQ5: all correspondences during tender clarifications and agrees with Olsson et al. (2018) Jain & Khurana (2015), and Costantini et al. (2021). The remaining factors CQ1: clear project scope document (agreed by Turner et al. (2019), Kujala et al. (2015), Andersen et al. (2016), Sarmiento & Renneboog (2016) and Bellengar (2003)), CQ2: clear technical & priced bid documents (as agreed by Annabeth, Pernille, & Erik (2015)) and CQ3: clear terms & conditions (as agreed by Song et al. (2018) and Lappi & Aaltonen (2017) ranked in the middle scoring 18% for each of CQ's sub-criteria. This study also gives the decision-makers less focus on PM, unlike the literature reviews. PM's sub-criteria pairwise comparison was conducted, and 40% was the highest weight for PM1: project initiation, and it is as per Naoum & Egbu (2017), Amoatey & Anson (2017), Naoum & Egbu (2016), and Project Management Institute, Inc. (2013). The lowest score was 5% for PM3: project execution and Project Management Institute, Inc. (2013). PM2: Project planning, PM4: project monitoring & controlling, and PM5: project closeout & lessons learned respectfully. The weight was 25%, 21%, and 9%. All respectfully for PM2 is agreed by Kagogo & Steyn (2019), Amoatey & Anson (2017), and Project Management Institute, Inc. (2013), for PM4 is agreed by Ajmal et al. (2021), and for PM5 is agreed by Turner et al. (2019), and Project Management Institute, Inc. (2013).

The AHP framework in this research resulted in a ranking of 15 factors based on the evaluation of the local situation by the O&G industry experienced professionals. Figure 4 shows the six critical factors to overcome the scope creep, which the first four rankings go to 4 out of 5 TM and the last rank, and before the last rank a factor of CQ (Well written contracts). It means that the project manager should plan and organize project resources to overcome any potential risk of scope creep. The project execution shall comply with the project charter, including the plan's defined scope and work breakdown.

Figure 4 The main two dimensions that include the six critical factors for overcoming PSC



The critical factors are TM1: the tender strategy ranked the highest at 17.7%, and the PM3: project execution ranked lowest at 0.5%. Such results agree with Galli et al. (2021), GlobalData plc. (2019), Naoum & Egbu (2016), Eba (2014), and Adedokun et al. (2013), who emphasize procurement strategy or early deals with potential causes of scope creep against later action during project execution to overcome scope creep and this contradicts with Naoum & Egbu (2016) and Project Management Institute, Inc. (2013). The second critical ranked was TM4: tender clarifications & negotiation meetings at 15.6%, followed by the third critical ranked for TM2: tender documents preparation and TM5: technical & commercial bid evaluation and award at 10.4%, CQ4: fourth-ranked for well-written contracts at 9.9%. Those mentioned above five critical factors are the second primary goal of this research and contribute to bridging the knowledge gap. As per Amoatey & Anson (2017), the leading causes for PSC are due to client changes, unclear scope, and unforeseen potential risks. Accordingly, the results support the practitioners focusing on fixing project scope with a rigid plan to overcome PSC early through a roadmap guided by the project contract. It also emphasizes and limits the project manager's role during project execution to focus only on monitoring and controlling projects and keeping the execution phase fully compliant with contract guidelines. The results tell us that well-written contracts contain clarity, terms & conditions, project scope, bids, all tender clarifications correspondences, and qualified suppliers are the main six critical factors in the dimensions of tendering management and contract quality.

In addition, to support project manager during any un-clarity of contracts during the execution of the contracts and administrating the contracts by the user.

## **6. CONCLUSION, IMPLICATIONS, LIMITATIONS, AND FUTURE RESEARCH**

### **6.1 Conclusion**

This study generally provides 15 critical factors based on the literature reviews to eliminating the PSC problem. All those factors are from TM, CQ management, and PM. Specifically, the research focus on the TM that has a crucial role in solving the PSC problem in the UAE O&G sector. Those UAE companies that implement those criteria of the AHP framework will succeed in all aspects of PM and business management. The success is due to implementing a procurement strategy through good communication and coordination with all project stakeholders to clarify and manage project requirements. This study provides the AHP framework as a platform for business management and PM to face any issue related to PSC in any industry. This study has emphasized the importance of tendering strategy, planning, tender documents, clarifications, and negotiations meetings and activities in addition to well compiled and written contracts to overcome the leading causes for PSC due to client changes and unclear scope, and unforeseen potential risks. Both oil and gas industry project managers and procurements managers must focus their strategies, goals, policies, and procedures on the activities related to quality TMs and well-drafted contracts document while deciding on any projects issues to reach projects success in terms of budget/cost, schedule, and scope quality.

### **6.2 Managerial and Theoretical Implications**

This study shows the critical role of procurement/contract manager and a project manager or coordinators also; for example, the contracts manager shall focus on the project's tender management activities such as reviewing project charter or scope and prepare tender documents as per tendering plan or strategy to include the way of tendering, bidding instructions, clarifying bidders for any tender inquiries and awarding it to the successfully qualified supplier after fair evaluations as per defined bid evaluation criterion to prepare contracts documents. Contracts manager or commercial manager supervises their teams to prepare contracts documents, which contains clear clarified project scope, project protocol or terms and conditions, technical and commercial bids, miscellaneous documents, or correspondences related to project clarifications, project's time, cost, and supplier. All are to be integrated into one well-defined document (Project contract) to guide the project manager in executing



the project. The contracts can be reviewed in advance by the project manager and supplier/contractor/service provider before being signed by both parties under contracts manager witnesses or initial after that project manager role comes to administrate this contract via project execution and monitor the progress of the project as per contract. In case of any deviation, contracts can tell the contract administrator how to deal with such change. This study focuses on negotiation skills to simplify any complexity of the undefined scope, and they must spend considerable time in negotiations. The main task of a procurement negotiation is to clarify the scope of requirements, deliverables, specifications, works/services, purchasing of goods, and so on in any contracts before awarding a tender to the successful supplier and signing the contract document. During project execution, contract negotiation is an independent process with a list of technical items & issues, scope change, etc. This commitment document determines suppliers ' authority and responsibility as an input and output of documented actions and decisions.

This empirical research emphasizes the critical role of Contracts Business Units (CBU) of procurement business units in the oil and gas industry. CBU is the concerned unit for all functions and activities related to establishing the tendering activities and preparation of contracts for engineering, procurement, and construction (EPC) projects; information technology and enterprise projects; operation and maintenance work and services; consultancy services; staffing services; and other work and services. The CBU Functions Process is to develop contracts through three main stages, as follows:

1. Pre-tendering
2. Tendering and evaluation
3. Awarding and compiling the project contract.

For Theoretical implications, this paper adds to the body of the knowledge a value related to PM/procurement management/supply management literature. The findings fill the knowledge gap of fewer references related to the PSC issue in the O&G industry in the UAE. Accordingly, researchers and students will focus on procurement or supply chain management as per project requirements to overcome the scope creep problem by using this paper research as learning materials or reference to their research. Specifically, TM is the critical factor that leads to quality contracts, which interface with PM to produce a clarity project requirement and mitigate PSC.

### **6.3 Research Limitations and Future Research**

There are several limitations to this research. Firstly, the geographical location is limited to the Emirate of Abu Dhabi, while it can be extended to other sixth Emirates, e.g., Dubai. This study was conducted in one of the Gulf Cooperation Council Countries, the UAE, which means the study model can be extended to be tested the other six countries, e.g., Saudi Arabia, Oman, Kuwait, etc., or any Middle East countries. Secondly, the industry was limited to the oil and gas sector. At the same time, it can be extended to other industries or other energy industries such as nuclear, renewal energy, etc. The data was collected from ten experts working in the procurement unit in Abu Dhabi-based company and senior academics. However, for future research, data can be collected from the contractor's side.

Future research should focus on the tendering strategy and other tendering activities of the oil and gas industry. In another way, tendering management impact in PSC thru contract quality as mediation can be tested in the same context of the UAE. The effect of the proposed framework will be tested in the future using a quantitative research method via distributing a survey questionnaire to 360-degree stakeholders dealing with procurement and tendering management in the oil & gas industry to get more exciting and confirmed results.

### **FUNDING AGENCY**

The publisher has waived the Open Access Processing fee for this article.

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