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Design of Technical Evaluation Criteria for Procurement of Maintenance and Repair Services in Upstream Oil and Gas Companies

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ABSTRACT

In the process of procuring services for the selection of contractors in upstream oil and gas companies that comply with PTK 007 SKK MIGAS regulations, an appropriate decisionmaking method is needed, in accordance with the scope and can be applied, where the technical evaluation assessment requires multiple criteria with respective weightings. Previous research has mostly been carried out in the construction and non-upstream oil and gas industries where the determination of criteria has not been precise and practical as needed which can affect technical evaluation failures. These multi-criteria decision-making methods use the Analytical Hierarchy Process (AHP) method, the results of which can be made into a mathematical model to determine the assessment of each potential winning contractor. The research began with identifying the criteria for previous research, the criteria currently used, and the classification of the appropriate criteria where the preparation was carried out using a questionnaire and a Forum Group Discussion (FGD) which was divided into 2 stages until each weighting criterion was obtained. This study resulted in 4 main criteria with 16 sub criteria where the main criteria with the highest weight was the ability to maintain and repair at 38.5%, with 2 sub criteria categorized as passed failed.

KEYWORDS: Qualification, Technical Evaluation, Production Facility, Multi Criteria, Sub Criteria, AHP

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1. INTRODUCTION

The upstream oil and gas industry basically has business uncertainty because it depends on changes in world oil selling prices, regulatory factors and government policies. This industry requires large investments in the development and exploration of oil and gas fields, infrastructure or production facility, requires the latest technology and innovation, high in complexity, has a high level of safety risk, require human resources who are competent in their field and must comply with rules, regulations and standards that are strictly required. The decline in oil and gas production was not only influenced by the condition of depleted oil and gas reserves, but also caused by problems with production facility instruments, especially for old facilities, which require maintenance and development of production facilities whose implementation is heavily influenced by the process of procuring goods or services and this must follow regulation PTK 007 SKK MIGAS. Intensive maintenance programs, especially for old facilities, need to involve maintenance contractors with high technology, special technical capabilities and personnel, having a good, experienced contractor maintenance management system, have complete supporting equipment, and comply with company regulations regarding aspects of Health, Safety, Security and Environment (HSSE).

The stages of the goods or services procurement process according to PTK No 007 (SKK Migas, 2017) include procurement planning or requests, preparation of procurement documents, procurement announcements, registration of procurement participants, assessment of the qualifications of potential participants, providing explanations, submission of bids, technical evaluation, negotiation, evaluation price or commercial announcement of the results of the procurement, designation of the winner and the process of making a contract which is followed by the implementation of services or the delivery of goods. The stages of procurement qualification and technical evaluation play an important role in determining the selection of suppliers or contractors. Inappropriate selection can have negative impacts, such as non-performance of work, inappropriate delivery of goods, equipment damage, production losses, material losses, and can affect HSSE aspects.

Selection of a contractor involves a complex multi-criteria process where each criterion used has different interests, the right criteria according to the scope, specifics and according to its application so that a method is needed to overcome these problems. Previous research has suggested that the selection of contractors in the construction and general industries is crucial to ensuring good quality. By using comprehensive, appropriate, and appropriate selection criteria, negative impacts that may arise as a result of contractors not meeting standards can be avoided. Some avoidable problems include delays in project completion, unexpected cost increases, low quality of work, and other issues that can affect the success of the contractor's (Balubaid & Alamoudi, 2015; Chen et al., 2020; Erdogan et al., 2017; Gurgun & Koc, 2020; Khoso et al., 2021; Semaan & Salem, 2017).

Previous studies (Balubaid & Alamoudi, 2015; Chavosh Nejad et al., 2021; Erdogan et al., 2017; Gurgun & Koc, 2020) in making decisions regarding which criteria are used with their weighting, including determining the selection of contractors were mostly carried out using the AHP method, or combined with other methods (Wang et al., 2016) which using AHP fuzzy and TOPSIS fuzzy in the military industry, (Semaan & Salem, 2017) with the AHP, PROMETHEE and MultiAttribute Utility Theory methods (MAUT) in the construction industry and several other Multi Criteria Decision Modeling (MCDM) methods applied to contractor selection and decision making on existing alternatives.

Previous research related to the determination of multi-criteria, especially in the construction industry, consist of technical capabilities such as the availability of workshops with equipment, competent worker qualifications, quality of work, linkages with similar project experience, work planning, fulfillment of specifications and reliability of equipment and international standards (Afolayan et al., 2020; Dissanayake et al., 2023; Erdogan et al., 2017; Gurgun & Koc, 2020; Khoso et al., 2021; Maqsoom et al., 2019; Semaan & Salem, 2017; Wang et al., 2016). This research also involves management capabilities, namely previous performance evaluations, organizational compliance, sub-contractor management, risk management, human resource development programs (Chen et al., 2020). Criteria by previous researchers including by (Balubaid & Alamoudi, 2015; Maqsoom et al., 2019; Petroutsatou et al., 2023) also includes compliance with HSSE, namely compliance with procedures, records of work accident rates or performance, safety management, safety and training programs, and environmental governance. Including other criteria that have been carried out by previous researchers, namely related to reputation and financial aspects.

The process of making decisions is a crucial factor, but it is often vulnerable to bias and inconsistency due to its reliance on intuition, subjective assessments, or emotions. Existing research has not sufficiently emphasized the implementation of suitable MCDM (Multi-Criteria DecisionMaking) methods in appropriate models. When selecting an MCDM method, it is essential to consider the type of data available in the model, including its criteria and characteristics. Currently, the process of selecting contractors based on multiple criteria has not yet achieved a satisfactory level of accuracy, practicality, or realism that aligns with the desired requirements (Khoso et al., 2021). The method for determining technical evaluation criteria is currently limited to being carried out by the contract owner with a subjective approach, the standard mechanism for determining multi-criteria including determining weighting does not yet exist and relies on the professional judgment or intuition of the contract owner. The potential for failure and repetition of tenders occurred several times due to the non-fulfillment of some of the criteria and the performance of the selected contractors not meeting expectations. There is no specific research in the upstream oil and gas industry or companies, especially the procurement of repair and maintenance services for instrumentation equipment, the use of reputation and financial criteria that are often used in the construction industry in technical evaluation is not appropriate and HSSE criteria in the upstream oil and gas industry are mandatory and are not weighted as in previous studies so that this became

the basis for this research. This research requires a literature review, determination of appropriate and applicable multi-criteria, weighting determination is carried out using the AHP method and the need for technical evaluation assessment modeling to assist the contractor selection process for further price negotiation, evaluation and determination of tender winners.

2. LITERATURE REVIEW

In the oil and gas industry in Indonesia, the implementation of the process of procuring goods and services follows PTK 007 regulations, namely in the form of Guidelines for Working Procedures for Supply Chain Management Book Two. This guideline is intended to provide a legal basis for procedures, integrated technical and administrative implementation guidelines. The implementation of procurement of goods or services aims to obtain and utilize the goods or services needed in quantity, quality, price, time and place in an appropriate, effective, efficient and accountable manner as well as creating a multiplier effect for the national economy. The goods or services procurement process starts with the procurement planning or request process followed by document preparation by the contract maker or owner, tender registration, pre-qualification, explanation to bidders who pass pre-qualification, submission of bids, technical evaluation of incoming bids, announcement of the results of the technical evaluation, negotiations, commercial evaluations, designation of winners and the completion of the contract making process followed by the implementation of services or goods.

The pre-qualification stage consists of two evaluation stages, namely administrative and technical, which have several criteria according to the scope and requirements of the contract. Administrative evaluations that are prerequisites for bidders include: compliance with a Centralized Integrated Vendor Database (CIVD), business license category, business sector and class, special relations or subsidiaries, shareholder data, financial capacity for a tender package value of over 200 billion rupiah and above , fulfillment of the statement letter including the commitment to the management of Occupational Safety, Health and Environmental Protection (K3LL) and compliance with HSSE, the status of a domestic company and the suitability of the Health Safety Environment Management Certificate (SMHSE) issued by the KKKS with the requirements mentioned in the tender. The technical evaluation consists of evidence of the tender participant's experience within a period of 7 years that is similar to the scope of the contract, evidence of Basic Capability (KD) obtained from calculating the highest experience of a similar type. Both of these evaluations are Passed or Failed. While the technical evaluation uses a weighting scheme that allows for passed or failed criteria which are arranged according to the existing scope and reflects the ability, experience, commitment to carry out the work, and the fulfillment of all existing scopes to be carried out by the bidders.

Thomas Saaty created the Analytic Hierarchy Process (AHP) method, which is widely utilized in many fields, including business, information technology, quality management systems, etc (Saaty, 2004) is a method used to manage and solve decision making

problems Multi Attribute Decision Modeling (MADM) decisions. AHP helps evaluate and compare the importance of each criterion involved in the decision-making process and provides a rating of the available decision alternatives. This method uses a hierarchical approach to manage MADM problems more effectively, considering the various factors that influence the decisions to be taken so as to facilitate making the right decisions. In other words, AHP is a multi-criteria decision-making technique created to assist decision-makers in selecting the most important priorities, relative weights, and alternatives in a systematic decision-making process. AHP minimizes deficiencies in the decision-making process, such as lack of planning, focus, contribution, or ownership, which over time are critical that make it difficult to reach the right choice (Veisi et al., 2022).

TABLE 1. Literature Review Based on Criteria, Phase and Applied Industry

Author	Considered Main Criteria					Phase		Applied in Industry	
	Financial	Management	Technical	HSSE	Reputation	PQ	Technical Eval	Others	Oil & Gas
(Afolayan et al., 2020)	√	√	√		√	√	√	√	
(Maqsoom et al., 2019)	√	√	√	√	√		√	√	
(Wang et al., 2016)	√	√	√		√		√	√	
(Khoso et al., 2021)	√	√	√	√	√		√	√	
(Semaan & Salem, 2017)	√		√	√	√		√	√	
(Erdogan et al., 2017)	√	√	√	√	√		√	√	
(Balubaid & Alamoudi, 2015)	√	√	√	√	√		√	√	
(Gurgun & Koc, 2020)	√	√	√	√	√	√		√	
(Chen et al., 2020)	√	√	√	√	√		√	√	
This Research	Pra Qualification	√	√	Fix Weight	Pra Qualification		√		√

The decision-making steps with the AHP method start with defining the decision problem, developing criteria and alternatives in the form of a hierarchy that represent the decision problem, creating paired matrices, comparing one another using pairwise for weighting purposes by assessing a certain level of importance, determining weights for each criterion by normalizing the pairwise comparison matrix with averaging and normalization and then the ending step is doing consistency testing with the eigenvalue method and consistency ratio. Comparison consistency aims to ensure that the resulting comparison priority order is obtained from a series of comparisons that are still within the logical preference limits.

Previous literature study Table 1 was conducted to find contractors, what type of industry to apply, and the focus of research on the prequalification or technical evaluation stage in the service procurement process. Based on this research, research development was carried out that are appropriate and specific to the scope of procurement of instrumentation maintenance and repair services in the Indonesian upstream oil and gas industry which is appropriate and applicable, complying with PTK regulations 007 SKK MIGAS company regulations using the AHP method which is weighted and category criteria that will be made into a contractor selection scoring model that aims to help assess the capabilities and requirements needed within the scope of services needed so that contractors can select contractors that meet the minimum value of the procurement of these services. In developing criteria, identification of sub-criteria is also carried out from existing criteria to help prioritize these criteria according to existing sub-criteria. This study also determines which category of criteria is weighted, which criteria are included in the pre-qualification stage or are included in the existing scope and which criteria are included in the mandatory criteria and do not need to be weighted. The determination of criteria and sub-criteria as well as weighting is done by conducting questionnaires and group discussion forums (FGD)

3. METHODS

This general research was carried out with the stages of problem identification, data collection, data processing, data analysis and interpretation as well as drawing conclusions in the form of the final result in the form of weighting each criterion along with the contractor selection scoring model at the technical evaluation stage. Identification of problems is done by analyzing the criteria data that has been carried out in the tender process in upstream oil and gas, problems and criteria that existed in previous research, looking for variables that affect the contractor appraisal process, digging up information on which criteria are included in the pre-qualification and technical evaluation stages, looking for Relevant regulations mainly refer to PTK 007 and look for references to contractor assessment modeling that reflects the contractor's competence and ability to find the best contractor according to the requirements and can carry out the work according to the existing scope.

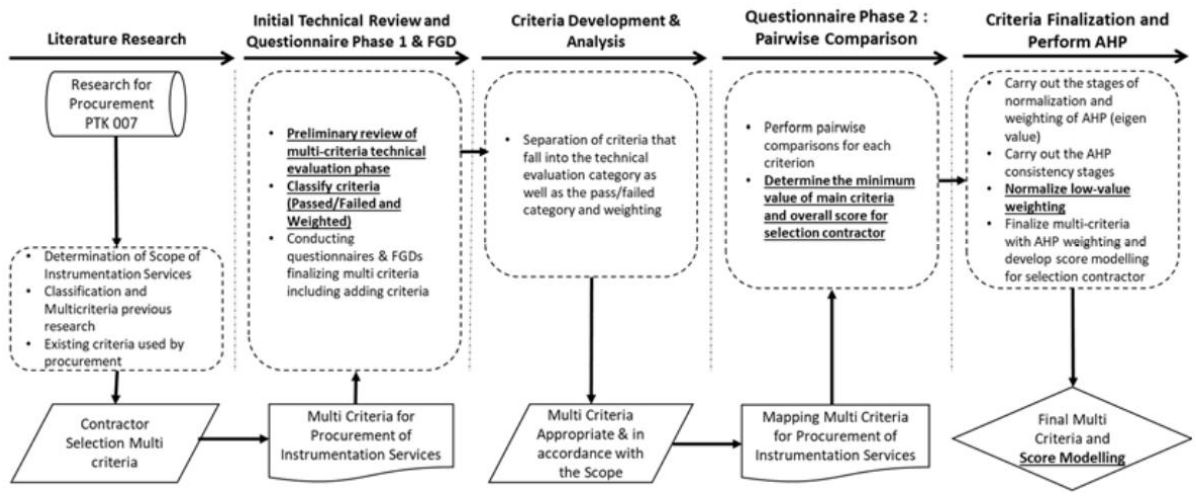

FIGURE 1. Methodology of Research to Find Best Multi Criteria

The initial stage of this research Figure 1 was a literature review in the form of determining the scope of instrumentation maintenance services, compiling multi-criteria from previous studies as an initial study along with determining whether the criteria classification was included in the category of passed failed criteria or criteria that required weighting according to the specified scope. This initial study was followed by conducting a phase 1 questionnaire and concluded in the FGD forum to determine the final multi-criteria and ensure the classification according to expert opinion. Questionnaires were conducted by experts in their fields representing contract users, contract managers including the procurement team, operations team as representatives of production asset owners and instrumentation engineering disciplines. From the results of the first stage of the questionnaire, the second stage of the questionnaire was carried out to carry out pairwise comparisons using the AHP method while simultaneously determining the minimum value of each criterion. From the results of this AHP, scoring model of the contractor selection assessment is carried out with the weighting of each criterion, and if the evaluation of the documents provided to the tender committee meets the minimum value of each criterion and the overall value then the prospective contractor can continue with the next tender process.

4. RESULTS

Prior to conducting an initial review, it is necessary to determine the scope of the contract which is the basis for determining the criteria, where the scope is the maintenance and repair of instrumentation equipment. In general, the services provided include the provision of personnel, special tools, and consumables for activities including:

1. Routine maintenance for a certain period of field instrument equipment, flow computer, control valve, manual valve, pressure safety valve with activities including inspection, measurement, calibration and functional tests, equipment integrity, cleaning and lubrication of mechanical parts and replacement of spare parts
2. Repair and test valves in the workshop with the scope of such things as: checking component completeness, leak testing, removing/cleaning/checking valves and

gear boxes, reassembling constituent components, blasting cleaning on valve bodies, inspections, Non Destructive Test (NDT), checking clearance and dimensions of equipment and parts, re-coating, polishing/grinding ball and stem, lapping and polishing seat parts, repair and replacement of spare parts, calibration, carrying out functional tests, installation and commissioning in the field.

From this scope, it is necessary for contractors to have workshops or cooperate with other parties with facilities such as digital test gauges, machining equipment, psv testing equipment, NDT equipment, sand blasting, tensioning and torquing, and supporting workshop equipment such as overhead cranes. Apart from that, it also requires special tools such as a Highway Addressable Remote Transducer (HART) communicator, programming and configuration tools, current calibration tools, voltage and current measuring instruments, greasing tools (pump/gun), leak test tools and torque wrenches.

Questionnaire 1 followed by a group discussion forum (FGD) was carried out by involving experts who were directly or indirectly involved in the use of this service contract where there were 11 correspondents from the maintenance, procurement, engineering and production operations sections with experiences between 8-20 years and have bachelor's degree for the last education. The results of the initial study followed by questionnaires and FGD Table 2 produced 4 main criteria with 16 sub criteria where 2 sub criteria related to the fulfillment of level II H2S personnel certification (KU1-4) and workshop ownership (KU3-1) are mandatory criteria and fall into the passed/failed category.

TABLE 2. The Results of Questionnaire 1 and FGD with the Addition of 1 Sub-Criteria and 2 Sub-Criteria were Categorized as Passed Failed

Main Criteria	Code	Sub Criteria	Category
Management Capability	KUI1	The Contractor's commitment to carry out tasks in accordance with the minimum scope includes work programs, implementation strategies, and the authority of the Project Manager in managing financial aspects approved by the Contractor's leadership	Weighted
		The contractor has a minimal organizational structure consisting of size, hierarchy, capabilities/experience, role responsibilities and job descriptions approved by the highest leadership	Weighted
		The contractor provides complete information regarding the personnel's curriculum vitae as well as a list of training and certification relevant to the scope of work	Weighted
		The contractor provides a statement letter confirming his commitment to provide certified personnel for handling H2S level II	Passed/Failed
General	KU2	The contractor has an ISO certificate or other related international standards	Weighted

Main Criteria	Code	Sub Criteria	Category
Technical Capability		The contractor has QA/QC quality control performance standards which include: QA/QC diagrams, procedures, checklists and reporting	Weighted
		The contractor has an execution plan that includes implementing organizations, spare parts/equipment procurement plans, provision of personnel, sub-contractors and communication protocols	Weighted
Maintenance and Repair Capability	KU3	The contractor has an ISO 90001/9002 standard workshop or cooperates with other parties who support the work by attaching agreements/proof of ownership according to the scope	Passed/Failed
		The contractor provides suitable special equipment in the workshop	Weighted
		The contractor's workshop has a certain maximum distance	Weighted
		The contractor provides special tools complete with maintenance procedures and evidence of their implementation in accordance with the scope	Weighted
		The contractor provides a maintenance schedule plan containing a list of activities, tools, materials according to manufacturing standards	Weighted
		The contractor has regular (3 or 6 or 12 monthly) and non-routine maintenance procedures accompanied by a checklist and spare parts	Weighted
Competency Capabilities	KU4	The contractor has workers with permanent/contract status complete with a curriculum vitae according to qualifications, certification, minimum education and has a letter of support for manufacture/authorized service related to special experts	Weighted
		The contractor is proven to have experience in the petrochemical, upstream oil and gas industry and the like according to the type of work in the existing scope	Weighted
		The contractor has a human resource development program in the form of training, recruitment process, competency matrix and employee assessment	Weighted

The second questionnaire was conducted with a focus on obtaining the minimum score for each criterion and the minimum for all criteria as well as pairwise comparisons for further analysis using the AHP method. The minimum score for Table 3 is obtained with a minimum scoring range between 60 and 75. The HSSE criteria according to the regulations of upstream oil and gas companies are mandatory criteria where in this study a weighting of 20 percent is determined. The weighting of the results of the AHP method is proportional to the HSSE weight of 0.2 with the 2 highest weighted criteria according to Table 3 are maintenance and repair capabilities and competence capabilities with a total weight of 62.4 percent of the total weight of the 5 existing criteria. The AHP

consistent test with a value of 0.021 which is less than 0.1 states that the paired matrix of the results of the second questionnaire is still within the limits of logical preference.

TABLE 3. Result of Main Criteria AHP Including Criteria HSE with Consistency Number

Main Criteria	Code	Final Minimum Grade (Kxmin)	Main Criteria Weight	Main Criteria Ratio Consistency
Management Capability	KU1	60.85	0.086	0.021
General Technical Capability	KU2	61.77	0.090	
Maintenance and Repair Capability	KU3	72.23	0.385	
Competency Capabilities	KU4	68.14	0.239	
HSE Capabilities	KU5	75	0.200	
Overall Minimum Value		65.44		

In previous research related to supplier selection modeling with multiple criteria using linear mathematical models and data envelopment analysis (DEA) methods, namely an approach where weighting is derived from supplier performance assessments, not from weighting derived from decision makers such as AHP (Ng, 2008). Linear modeling in this study in general the maximum rating of a supplier S is the sum of each supplier is weighting on criterion j (w_{ij}) with a linear transformation of the supplier's performance measurement against criteria y_{ij}.

Modeling the main criteria by deriving and creating a linear model for contractor selection from the reference by adding xpf_{ij} which is criteria passed/failed category, so that the maximum value of a contractor i with criteria j (w_{ij}) and contractor assessment of criteria (y) that is S (4.1; 4.6) determined by fulfilling the criteria in the category of passed/failed xpf_{ij} with the total rating of each criterion with its weighting $w_{ij}y_{ij}$.

From the two references above and in particular this study uses the AHP method where it is known that there 5 main criteria anf the minimum assessment of each criterion, the minimum assessment of all criteria in Table 3, a scoring model approach can be used to evaluate contractor selection with xpf_{ij} which are criteria that fall into the category of passed/failed as follows:

$$\text{Max } S_{tot_i} = xpf_{ij} * \sum_{j=1}^{j} w_{ij}y_{ij} \quad (1)$$

where, $S_{tot_i}, y_{ij} \geq Kx_{min}$, minimum scoring of bidder Table 3 that state passed from technical evaluation. (2)

$$\sum_{j=1}^{j} w_{ij} = 1 \quad (3)$$

$$w_{ij}, y_{ij} \geq 0, j = 1,2,3, \ldots, J \quad (4)$$

$$xpf_{ij} = 1 \; or \; 0, \text{(1 if fullfilled, 0 not fullfilled)} \quad (5)$$

$$Max\ S_{tot_i} = (\mathrm{KU1} - 4_i) * (\mathrm{KU3} - 1_i) * [0.086 * (\mathrm{KU1}_i) + 0.09 * (\mathrm{KU2}_i) + 0.385 * (\mathrm{KU3}_i) + 0.239 * (\mathrm{KU4}_i) + 0.2 * (\mathrm{KU5}_i) \quad (6)$$

Some constraint applied for formula (1), minimum value of each criterion and total value (2), the total weight is 1 after normalization (3), the limitation that the value of the weight and criteria cannot be less than zero or negative (4). This main criterion modeling describes the total value of the technical evaluation assessment obtained from the results of the analysis of the prospective contractor by the service contract user function who is part of the tender committee, for supporting documents and evidence sent after the pre bid process together with bidding or commercial documents. Any prospective contractor who meets a minimum total score of 65.44 is declared to have passed and can take part in the commercial evaluation and negotiation stages. KMH_2S management capabilities to have certified personil H_2S Level 2 and KPP-WS maintenance and repair capabilities are in the form of a statement, management commitment and proof of ownership/workshop cooperation which must be included in the tender document, so that if it is incomplete, it is considered that the requirements are not met or a value of 0 and can abort the evaluation overall technical assessment.

5. CONCLUSIONS

Based on research and analysis of technical evaluation assessment criteria in the procurement of maintenance services and repairs of instrumentation equipment in upstream oil and gas industries using the AHP method, multi-criteria are obtained that are appropriate, precise and applicable according to the existing scope of work and a mathematical modeling of the contractor's assessment is obtained for the selection process at the technical evaluation stage in accordance with PTK regulation 007 SKK MIGAS. The conclusions obtained apart from the multi-criteria and modeling include 2 of the 16 sub-criteria that fall into the passed/failed category, criteria such as reputation and finance are not included in the technical evaluation criteria, HSSE criteria are set at a constant value according to existing company regulations, strengthening of Previous research found that technical aspects such as competence and technical maintenance were the criteria with the highest weighting and found differences in weighting, especially in the HSSE criteria where in the upstream oil and gas industry the most important things apart from production, quality and reliability of production facilities are therefore required to be included in the contractor selection criteria. This research needs to be developed with a different scope, applied to contracts with a wider scope such as Engineering Procurement and Construction (EPC), the use of other MCDM methods according to the availability of existing data on the procurement of these services and further applied in the upstream oil and gas industry and the like.

The impact of this research on a managerial basis in a company includes the direct application of the AHP method referring to this research on a certain service procurement so that it can provide benefits, especially in the accuracy of criteria and weighting that is more precise and appropriate, providing insight and development for company management that the method is needed in every decision making, obtains service contractors that comply with existing requirements and criteria thereby reducing the impact of contractor incompetence and can be an initiative for companies to create a standardization in the form of procedures in the form of Organizational Governance and Governance or manage contractor selection using the MCDM method both at the prequalification and technical evaluation stages.

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