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Tender Evaluation Improvement at PT. X Using Analytical Hierarchy Process

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ABSTRACT

A project is part of the activity done by the company in order to achieve its business goal. One of the activities inside a project is tendering to ensure the availability of the resources needed for the project is fulfilled. PT. X is one of the companies that implement the tendering process to achieve its business goal. One of the operations that require the tendering process is the security operation. The tender announcement is made public for any vendors able to fulfilled the requirement can apply for the tender and follow the selection process. The selection process is conducted by the procurement committee and the contract engineer. They determined the tender evaluation criteria and give scores to each of the criteria. In the current condition, the determination of the weight is prone to subjectivity due to the non-existence of any quantitative method in the decision-making process. This study proposes the use of the Analytical Hierarchy Process (AHP) as a tool to help the company to determine the criteria, sub-criteria, and each of the weights as the quantitative method. This method reduces the subjectivity factor and ensures a structured decision-making framework. The winner of the tender from this study and the current condition are the same. However, the final score is different, and the vendor with the lowest score is also different. This difference is due to the different weights in the current condition and this study.

Keywords: Analytical Hierarchy Process, tender, decision making, scoring method, vendor.

ABSTRAK

Proyek adalah bagian dari kegiatan yang dilakukan oleh perusahaan untuk mencapai tujuan bisnisnya. Salah satu kegiatan dalam sebuah proyek adalah tender untuk memastikan terpenuhinya ketersediaan sumber daya yang dibutuhkan untuk proyek. PT. X merupakan salah satu perusahaan yang melaksanakan proses tender untuk mencapai tujuan bisnisnya. Salah satu operasi yang memerlukan proses tender adalah operasi pengamanan. Pengumuman tender dilakukan untuk umum sehingga vendor yang memenuhi persyaratan dapat mengajukan tender dan mengikuti proses seleksi. Proses seleksi dilakukan oleh panitia pengadaan dan teknisi kontrak. Mereka menentukan kriteria evaluasi tender dan memberikan skor untuk masing-masing kriteria. Kondisi saat ini, penentuan bobot rentan terhadap subjektivitas karena tidak adanya metode kuantitatif dalam proses pengambilan keputusan. Penelitian ini mengusulkan penggunaan Analytical Hierarchy Process (AHP) sebagai alat untuk membantu perusahaan dalam menentukan kriteria, subkriteria, dan masing-masing bobot sebagai metode kuantitatif. Metode ini mengurangi faktor subjektivitas dan memastikan kerangka kerja pengambilan keputusan yang terstruktur. Pemenang tender dari studi ini dan kondisi saat ini sama. Namun, skor akhir berbeda, dan vendor dengan skor terendah juga berbeda. Perbedaan ini disebabkan oleh perbedaan bobot pada kondisi saat ini dan penelitian ini.

Kata Kunci: *Analytical Hierarchy Process, tender, decision making, scoring method,* ***vendor****.*

1. Introduction

PT. X is an oil and gas company that operates in Indonesia. To support its operation, PT. X has several projects. A project is a temporal set of works to develop a one-of-a-kind outcome, service, or product (Project Management Institute, 2017). Each of the projects is being managed through the project management knowledge area. One of the knowledge areas is procurement management. Project Management Institute (PMI) defines procurement management as the required process to acquire items, services, or results from resources outside the project team (2017). An efficient process of procurement is critical for a company's survival and

profitability, and the effectiveness of the public sector to gather resources for social expenditures and/or cut taxes (Dimitri, Piga, & Spagnolo, 2006)

One of the methods to find the resources is through tender. Tender is a series of activities to provide goods and services by creating fair competition among equal and qualified providers of goods/services, based on certain methods and procedures that have been determined and followed by the relevant parties in accordance with the principle so that the best provider is chosen (Ervianto, 2005). PT. X has used tender as a way to fulfill their resources, specifically in the Security Operation.

The current process of tender in PT. X starts with internal preparation, where the procurement committee and the contract engineer (Contract and Procurement Division) decide who is in charge of the tender and make the tender's draft procedure requirement, including the criteria evaluation and the draft of tender advertisement. The next step is the announcement & registration, where the procurement committee publishes the announcement through the announcement board, website, and other media. The announcement provides guidance related to tender registration.

The third step is pre-qualification where the vendors are evaluated for their scope of work and capability. The next step is the pre-bid meeting where the procurement committee and the vendors (bidders) meet to discuss anything related to the tender requirement that needs to be evaluated. The fifth step is the bid opening where the bidders bring documents (according to the tender requirement) in an envelope and it shall be opened during that time. The sixth step is the procurement committee evaluates the bidder based on the submitted document. The evaluation starts with an internal discussion on giving the weight to the predetermined criteria, and then the procurement committee provides the score to each bidder. Currently, the determination of the weight for each criterion only follows the feeling of the committee, which leads to subjectivity.

The seventh step is determining the winner by calculating the weight and score of each bidder. The bidder who received the highest total score is the winner of the tender. This result should be approved by the President Director of the company. Once the winner is approved, the winner will be announced to the public.

The subjectivity in the sixth step leads to an improper determination of the criteria weight that leads to the decision to choose the incorrect winner for tender. This is reflected in the high number of projects that were neglected due to the inability of the vendor (the winner of the tender) to perform in accordance with the agreement.

This research will focus on helping PT. X in the evaluation process of the technical document by applying one of the multi-criteria decision-making (MCDM) tools, the Analytical Hierarchy Process (AHP), to the elements appraisal value system and the assessment of criteria based on the criteria from the procurement committee (Merit Point System). Various studies in the different fields consider AHP as the most common and effective MCDM method (Waris, et al., 2019). AHP is built to deal with both the rational and intuitive aspects of choosing the best option from a set of options based on a set of criteria (Saaty & Vargas, 2012). Another purpose of AHP is to assist analysts to discover the optimal alternative by addressing each component of the failure in the hierarchy and reducing difficult choice issues methodically and analytically (Khaira & Dwivedi, 2017).

2. Methods

2.1 Initial Observation

An observation is made in the Contract and Procurement Division of PT. X. The initial observation aims to identify the current condition of the tender evaluation process in order to identify the suitable tools for the improvement.

2.2 Problem Identification

There is no quantitative method in determining the weight of each criterion to evaluate the tender document. The weight of each criterion is determined by the procurement committee and contract engineer subjectively.

2.3 Literature Study

After the problem is being identified, a literature search is conducted to find a suitable method related to the decision-making process. Moreover, it is used as the basis of the steps to conduct the research. The literature search is obtained from books, journals, and other sources related to the research topic.

2.4 Data Gathering

The data is gathered through two processes, interview, and database review. The interviewee is the people in charge of the tendering process, such as the procurement committee, contract engineer, and manager of the contract service. The database review is looking through the data of the ongoing tender process (technical assessment, criteria to choose the winner of tender) based on the approval of the contract & procurement division.

2.5 Analysis

The next step is to identify and classify the criteria that have been used to determine the winner. Then, analyze the collected data, and give weight to the criteria based on the preference of the people in charge of the tendering process. After that, the weight of each criterion is evaluated considering the goal, while the sub-criteria are evaluated considering the criteria. The difference between the winner (using the proposed method) and the current winner will be analyzed also.

2.6 Conclusion and Recommendation

Based on the research, the conclusion can be derived related to the criteria, sub-criteria, and weight. Recommendation for further research is also discussed in this section.

3. Result and Discussion

3.1 Identification of Criteria and Sub-Criteria

An interview and discussion were conducted with the Contract Engineer (1 person) and the Procurement Committee (2 people). The questions that are being discussed are related to the existing methodology to evaluate the tender, the current way to decide the weight of criteria and sub-criteria, and the person who is responsible for the tender. Once the criteria and the sub-criteria are determined, the hierarchy is constructed. The hierarchy of the tender evaluation can be seen in Figure 1.

3.1.1 Project Management

The criteria of project management (PM) give insight into the organizational structure and personnel structure of the vendors. It also shows the working experiences, the job description, and responsibilities. The sub-criteria are organization structure (PM1), project operational organization chart (PM2), working facility and location (PM3), experiences for security services (PM4), employment agreement (PM5), payroll management system (PM6), personnel database (PM7), and SOP for schedule planning (PM8).

3.1.2 Security Operation and Strategy

The security operation and strategy (SOS) give insight into the vendors' existing procedures related to the security operation and the vendors' strategy to do the tender. The sub-criteria are SOP static and patrol guards (SOS1), SOP escort (SOS2), SOP investigation (SOS3), SOP emergency response procedures (SOS4), local community relation and approach (SOS5), intelligence and confidential issues (SOS6).

3.1.3 Equipment

The equipment (EQP) criteria give insight into the vendors' equipment specifications when doing the operation by providing the information in a brochure or catalog. The sub-criteria are PPE specification (EQP1), brochure or product catalog (EQP2), transportation proposal (EQP3).

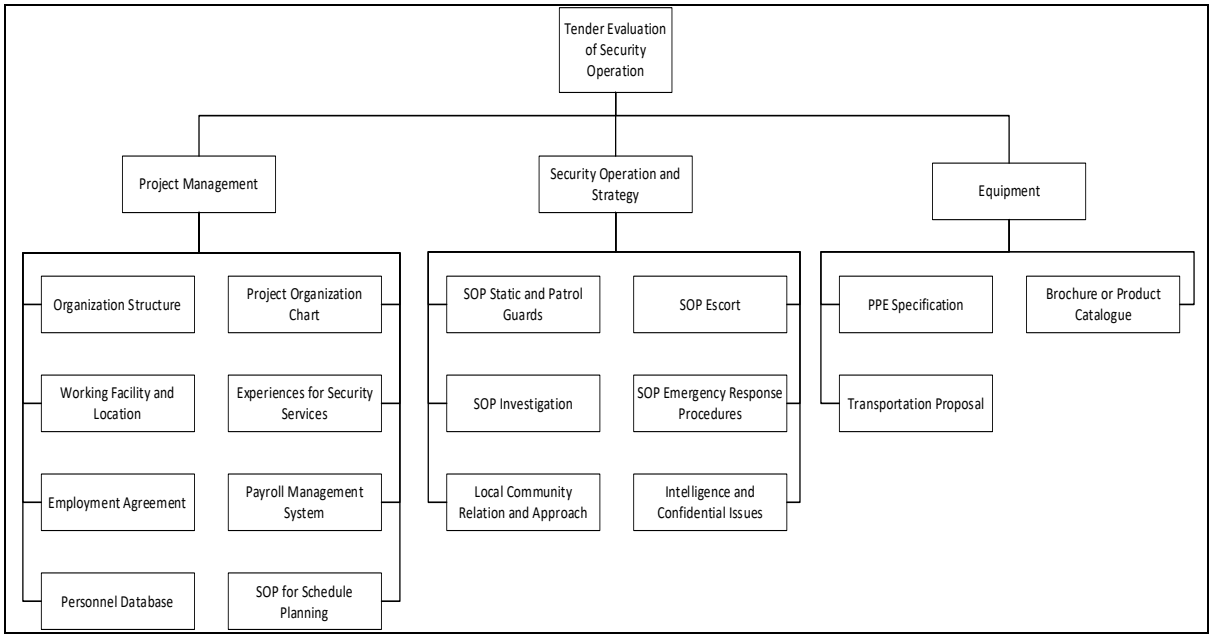


Figure 1. Hierarchy of the tender evaluation

3.2 Pairwise Comparison Matrix

Once the criteria and sub-criteria have been determined, another questionnaire was distributed to the same people to find the preference on which criteria and sub-criteria are the most important. Respondents were asked to choose between two criteria that are the more important and give a rate on the importance. The rates value is between 1 to 9 where 1 represents equal importance, while 9 represents absolute importance. The data then being calculated through pair-wise comparison.

The result of the pairwise comparison for the criteria is listed in the matrix in Table 1. The example of a pairwise comparison for the sub-criteria can be seen in Table 3. The final matrix for the criteria and sub-criteria is constructed through the geometric mean of the three respondents and can be seen in Table 2, Table 4, Table 5, and Table 6.

Table 1 Preference on Criteria

Criteria	PM	SOS	EQP	Criteria	PM	SOS	EQP	Criteria	PM	SOS	EQP
PM	1	1/5	1/5	PM	1	5	1/7	PM	1	1/5	4
SOS	5	1	5	SOS	1/5	1	1/7	SOS	5	1	7
EQP	5	1/5	1	EQP	7	7	1	EQP	1/5	1/7	1
First Person				Second Person				Third Person			

Table 2 Final Matrix of Preference Criteria

	PM	SOS	EQP
PM	1	0.585	0.485
SOS	1.710	1.000	1.710
EQP	1.913	0.585	1.000
Sum	4.623	2.170	3.195

Table 3 Preference on Sub-Criteria of Project Management

Sub-Criteria	PM1	PM2	PM3	PM4	PM5	PM6	PM7	PM8
First Person								
PM1	1	7	7	7	7	7	7	7
PM2	1/7	1	1/7	6	6	1/7	1/7	1/7
PM3	1/7	7	1	9	8	8	8	9
PM4	1/7	1/6	1/9	1	9	1/9	5	5
PM5	1/7	1/6	1/8	1/9	1	1/6	1/6	1/6
PM6	1/7	7	1/8	9	6	1	7	7
PM7	1/7	7	1/8	1/5	6	1/7	1	1/9
PM8	1/7	7	1/9	1/5	6	1/7	9	1
Second Person								
PM1	1	1/4	6	1/4	1/2	1/4	1	1/3
PM2	4	1	1	1	1	1/3	3	1/3
PM3	1/6	1	1	1/3	1	1/3	1	1/3
PM4	4	1	3	1	1	4	1	3
PM5	2	1	1	1	1	1/2	1	3
PM6	4	3	3	1/4	2	1	3	3
PM7	1	1/3	1	1	1	1/3	1	3
PM8	3	3	3	1/3	1/3	1/3	1/3	1
Third Person								
PM1	1	5	5	6	1/5	1/5	1/5	6
PM2	1/5	1	6	1/6	1	1	1/3	7
PM3	1/5	1/6	1	1/7	1/7	1/7	1/7	1/5
PM4	1/6	6	7	1	1/7	1/6	1/6	6
PM5	5	1	7	7	1	1	1	5
PM6	5	1	7	6	1	1	1	6
PM7	5	3	7	6	1	1	1	6
PM8	1/6	1/7	5	1/6	1/5	1/6	1/6	1

Table 4 Final Matrix of Sub-Criteria Project Management

Sub-Criteria	PM1	PM2	PM3	PM4	PM5	PM6	PM7	PM8
PM1	1.000	2.061	5.944	2.190	0.888	0.705	1.119	2.410
PM2	0.485	1.000	0.950	1.000	1.817	0.362	0.523	0.693
PM3	0.168	1.053	1.000	0.754	1.046	0.725	1.046	0.843
PM4	0.457	1.000	1.326	1.000	1.087	0.420	0.941	4.481
PM5	1.126	0.550	0.956	0.920	1.000	0.437	0.550	1.357
PM6	1.419	2.759	1.379	2.381	2.289	1.000	2.759	5.013
PM7	0.894	1.913	0.956	1.063	1.817	0.362	1.000	1.260
PM8	0.415	1.442	1.186	0.223	0.737	0.199	0.794	1.000
Sum	5.964	11.778	13.698	9.530	10.681	4.211	8.731	17.059

Table 5 Final Matrix of Sub-Criteria Security Operation and Strategy

Sub-Criteria	SOS1	SOS2	SOS3	SOS4	SOS5
SOS1	1.000	1.529	0.759	2.241	1.651
SOS2	0.654	1.000	1.317	1.211	1.211
SOS3	1.317	0.759	1.000	2.080	1.931
SOS4	0.446	0.825	0.481	1.000	2.154
SOS5	0.606	0.825	0.518	0.464	1.000
SOS6	0.763	0.759	0.539	2.033	0.794
Sum	4.787	5.698	4.614	9.029	8.741

Table 6 Final Matrix of Sub-Criteria Equipment

Sub-Criteria	EQP1	EQP2	EQP3
EQP1	1.000	1.186	1.533
EQP2	0.843	1.000	0.776
EQP3	0.652	1.289	1.000
Sum	2.496	3.475	3.308

3.3 Tender Decision

3.3.1 Consistency Determination

To be able to determine the weight of the criteria and sub-criteria, the consistency of the preference gathered in the previous section should be measured. The consistency ratio (CR) should be less than 10% to be categorized as consistent (Saaty & Vargas, 2012). The calculation of consistency ratio is as follow:

$$CR = \frac{CI}{RI} \tag{1}$$

Where CI is the consistency index and RI is the random consistency index. RI is based on the value of n (order matrix). Table 7 describes the value of RI based on the value of n.

Table 7 Random Consistency Index

N	1	2	3	4	5	6	7	8	9	10
Random consistency index	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

The calculation for the consistency index is:

$$CI = \frac{\lambda_{\max} - n}{n-1} \tag{2}$$

The value $\lambda_{\max}$ is the largest eigenvalue of the matrix. The summary of the consistency ratio calculation can be seen in Table 8

Table 8 Summary of Consistency Test

	$\lambda_{\max}$	CI	CR	Remarks
Criteria	3.031	0.016	0.027	Consistent
PM Sub-Criteria	8.710	0.101	0.072	Consistent
SOS Sub-Criteria	6.280	0.056	0.045	Consistent
EQP Criteria	3.030	0.015	0.026	Consistent

3.3.2 Weight Determination

The next step is determining the weight by multiplying the eigenvector of each criterion to every eigenvector of the sub-criteria. The summary of the weight for each criterion is shown in **Table 9**.

Table 9 Summary of Weight for Each criterion

Sub-Criteria	Eigen Vector Sub-Criteria	Eigen Vector PM	Weight	Sub-Criteria	Eigen Vector Sub-Criteria	Eigen Vector PM	Weight	Sub-Criteria	Eigen Vector Sub-Criteria	Eigen Vector PM	Weight
PM1	0.191	0.213	0.041	SOS1	0.210	0.455	0.096	EQP1	0.402	0.332	0.133
PM2	0.087	0.213	0.019	SOS2	0.175	0.455	0.080	EQP2	0.287	0.332	0.095
PM3	0.089	0.213	0.019	SOS3	0.222	0.455	0.101	EQP3	0.312	0.332	0.103
PM4	0.117	0.213	0.025	SOS4	0.128	0.455	0.058		1.000		0.332
PM5	0.093	0.213	0.020	SOS5	0.121	0.455	0.055				
PM6	0.236	0.213	0.050	SOS6	0.144	0.455	0.066				
PM7	0.117	0.213	0.025								
PM8	0.071	0.213	0.015								
Sum	1.000		0.213	Sum	1.000		0.455	Sum	1.000		0.332

3.3.3 Scoring Determination & Decision

In scoring determination, each vendor is given a score based on the completeness of the submitted document. The procurement committee is the one that determines the score based on the score matrix that is developed

beforehand. Once the scoring is done, then the final score of each vendor is calculated by multiplying the weight of each sub-criteria to the score given. The result of the calculation is shown in Table 10.

Table 10. Sub-Criteria Scoring of Vendor

Sub-Criteria	Weight	Vendor A	Vendor B	Vendor C	Vendor D	Vendor E
PM1	0.041	2.028	2.028	2.839	3.244	4.056
PM2	0.019	1.853	1.297	1.482	0.926	1.853
PM3	0.019	1.319	1.130	1.507	1.695	1.884
PM4	0.025	1.988	1.988	1.988	2.485	2.237
PM5	0.020	1.971	1.971	1.971	1.971	1.971
PM6	0.050	4.006	4.507	5.007	3.505	5.007
PM7	0.025	1.745	1.247	1.496	1.496	1.247
PM8	0.015	1.509	0.754	1.056	0.905	1.358
Sum	0.213	16.418	14.922	17.347	16.229	19.612
Sub-Criteria	Weight	Vendor A	Vendor B	Vendor C	Vendor D	Vendor E
SOS1	0.096	7.648	7.648	7.648	7.648	8.605
SOS2	0.080	6.390	5.591	4.792	3.993	7.987
SOS3	0.101	7.081	7.081	8.093	6.070	5.058
SOS4	0.058	4.077	4.660	5.242	5.242	5.242
SOS5	0.055	5.491	5.491	5.491	5.491	5.491
SOS6	0.066	6.553	6.553	6.553	6.553	6.553
Sum	0.455	37.241	37.024	37.820	34.998	38.936
Sub-Criteria	Weight	Vendor A	Vendor B	Vendor C	Vendor D	Vendor E
EQP1	0.133	6.670	9.339	13.341	13.341	13.341
EQP2	0.095	7.618	7.618	9.522	8.570	9.522
EQP3	0.103	10.347	10.347	10.347	10.347	10.347
Sum	0.332	24.635	27.303	33.210	32.258	33.210

Table 11 Total Score of Each Vendor

Vendor	Criteria			Total Score
	PM	SOS	EQP	
A	16.418	37.241	24.635	78.294
B	14.922	37.024	27.303	79.250
C	17.347	37.820	33.210	88.377
D	16.229	34.998	32.258	83.484
E	19.612	38.936	33.210	91.758

The winner is from the vendor who received the highest total score. From Table 11, Vendor E is the one who received the highest score of 91.758. Therefore, the winner of the tender is Vendor E.

3.4 Current Condition and Proposed Condition

There are some differences in the criteria and sub-criteria weight on the current condition and the proposed condition. The difference can be seen in **Figure 2** and **Figure 3**. In the current condition, PM criteria are given a weight of 0.35 while this study proposed 0.21; the weight of SOS criteria in the current condition is 0.4 while this study proposed 0.46; the weight of EQP criteria in the current condition is 0.25 while this study proposed 0.33.

These differences occur due to the method of determining the weight. In the current condition, the weight is determined directly by the procurement committee and the contract engineer. This method leads to huge subjectivity and is not able to accommodate the precision. Using AHP as the method to determine the weight gives a more structured framework that minimizes the subjectivity and ensures the consistency of the result.

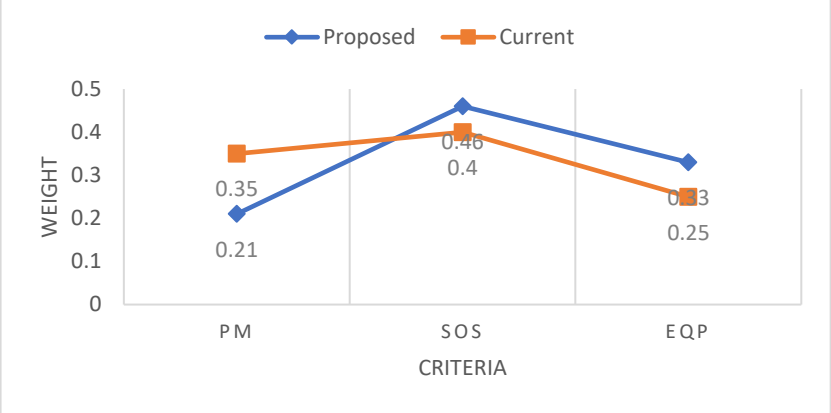
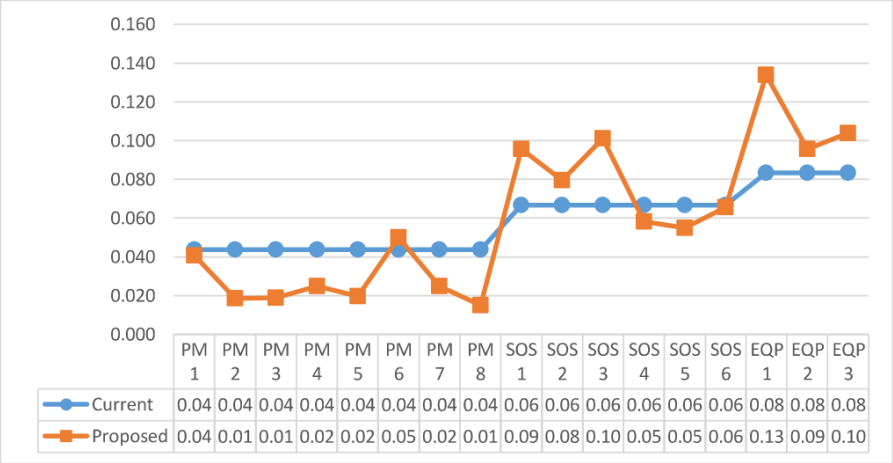


Figure 2. Weight Comparison of Criteria



	PM 1	PM 2	PM 3	PM 4	PM 5	PM 6	PM 7	PM 8	SOS 1	SOS 2	SOS 3	SOS 4	SOS 5	SOS 6	EQP 1	EQP 2	EQP 3
Current	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.06	0.06	0.06	0.06	0.06	0.08	0.08	0.08
Proposed	0.04	0.01	0.01	0.02	0.02	0.05	0.02	0.01	0.09	0.08	0.10	0.05	0.05	0.06	0.13	0.09	0.10

Figure 3. Weight Comparison of Sub-Criteria

Since the weight of the current criteria is different from the proposed study, the total score for each vendor is also different. The difference in the total score can be seen in **Figure 4**. Though this difference does not affect much on the decision of the winner (Vendor E received a score of 91.612 in the current condition and 91.758 based on this study), the decision of the vendor with the lowest score is different. In the current decision, Vendor B is chosen as the lowest score, while in this study is Vendor A. Using the AHP method as the tools to evaluate the tender ensures the weight for the criteria and sub-criteria is according to what the company needs and the consistency of the weight can be guaranteed.

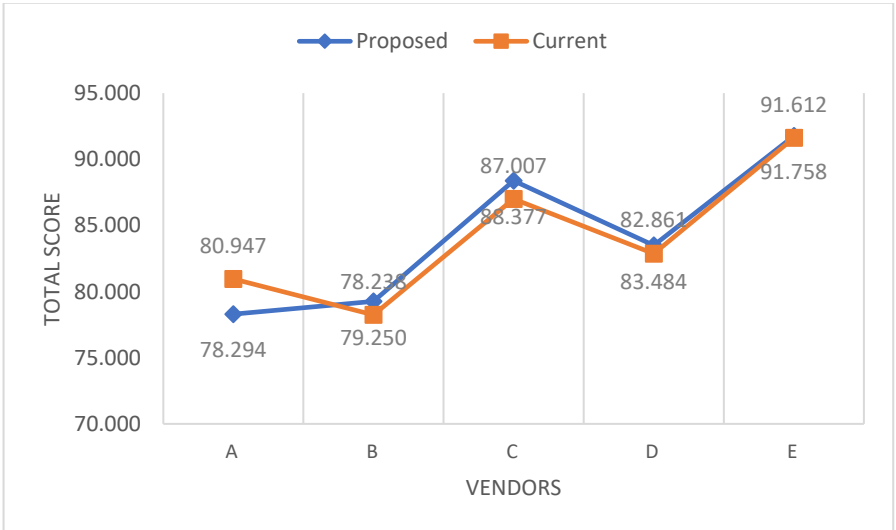


Figure 4. Vendor Total Score

4. Conclusion

The conclusion of this research is:

1. The tender criteria for Security Operation in PT. X are project management, security operation and strategy, and equipment.
2. The method of AHP reduces the subjectivity aspect when determining the weight of the criteria and sub-criteria by calculating the consistency ratio.
3. The winner of the tender process is Vendor E.

The recommendation for further research is:

1. A post-qualification study should be conducted to ensure the chosen vendor is the best one.
2. Another method of decision-making tools can be used, then compared the result as a way to find a more suitable method.

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