

# SUPPLIER SELECTION FOR A PHILIPPINE-BASED E-COMMERCE WITH ANALYTIC HIERARCHY PROCESS USING SUPER DECISION SOFTWARE

Eki Ruskartina<sup>1\*</sup>, A.A. Ngurah Perwira Redi<sup>2</sup>, Tennessee Khayte B. Bayot<sup>3</sup>, Gladysmae A. Ylan<sup>3</sup>

<sup>1</sup> Industrial Engineering Department, Universitas Teknologi Sumbawa, Sumbawa, Indonesia, 84371.

<sup>2</sup> Industrial Engineering Department, Faculty of Engineering and Technology, Sampoerna University, Indonesia, 12760.

<sup>3</sup> School of Industrial Engineering and Engineering Management, Mapua University, Manila, Philippines, 1002.

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## \* Penulis Korespondensi:

Eki Ruskartina

Program Studi Teknik Industri,  
Universitas Teknologi Sumbawa,  
Sumbawa, Indonesia, 84371

Email: [eki.ruskartina@uts.ac.id](mailto:eki.ruskartina@uts.ac.id)

**ABSTRAK.** Philippine-based e-commerce companies strive to improve their decisions to gain a competitive advantage. One of the crucial business decisions to gain a competitive advantage is choosing the best suppliers. The procurement process depends on choosing the finest suppliers, which also gives businesses a big chance for cost savings. We used the Analytical Hierarchy Process (AHP) which one of the Multi-Criteria Decision Making (MCDM) methods to select the best suppliers in one of the e-commerce in the Philippines. We utilized five criteria to judge three selected suppliers. The five criteria are Cost, Quality, Delivery, Payment Flexibility, and Variety. Based on the computational experiment that was processed in Super Decision Software, Supplier 2 is selected to be the best supplier among Supplier 1 and Supplier 3. Therefore, Supplier 2 may be selected as the best supplier for the unknown Philippine-based E-commerce company for the new product it is planning to launch.

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## 1. INTRODUCTION

The e-commerce industry in the Philippines has exhibited a steady growth trajectory in recent years, as substantiated by the revenue forecasts for the year 2020. The prospects of e-commerce in the country with the highest daily Internet usage are promising. According to a recent poll, customers in the Philippines used any device to browse a retailer's website or shopping applications to make purchases. Because of how convenient shopping online is for Filipino customers, the country's e-commerce spending surged as a result. E-commerce revenue in the Philippines is estimated at 3.55 billion USD, and the share of internet users in the Philippines that use shopping applications is 85.7%. Moreover, the Gross merchandise value of the Internet economy in the Philippines from 2019 to 2021 grew from 7.1 to 17 billion U.S. dollars. With the increased competition, Philippine-based e-commerce companies strive to improve their decisions to gain a competitive advantage.

One of the crucial business decisions to gain competitive advantage is choosing the best suppliers for the supplied goods. Making the appropriate supplier selection benefits the business (Alsuehri, 2011). For instance, it is advisable for enterprises to carefully evaluate the production capability of all potential suppliers and make informed decisions in selecting the most suitable ones. Additionally, firms should aim to establish enduring and mutually beneficial partnerships with these selected suppliers. The procurement process depends on choosing the finest suppliers, which also gives businesses a big chance for cost savings. However, choosing the incorrect suppliers can result in operational and financial issues.

Multiple-Criteria Decision Making (MCDM) is a technique that can be used to solve supplier selection problems. Chen-Tung et al in 2006 have been considered quantities criteria when selecting suppliers (Chen, Lin and Huang, 2006). In the context of Multi-Criteria Decision Making (MCDM), the task of a purchasing manager involves assessing the compromise between several criteria in supplier selection, particularly when a given issue is influenced by multiple conflicting factors. MCDM techniques provide assistance to decision-makers in the evaluation of a collection of options. The criteria need to be weighed because their weights fluctuate depending on the circumstances surrounding the purchase (Dulmin and Mininno, 2003).

The Analytical Hierarchy Process (AHP) is a decision-making method designed to assist individuals or organizations in reaching the best decision when faced with complex options. This method was developed by Saaty (1987) and was used to determine the possible combinations or solutions that can be implemented to achieve the ultimate goal of selecting the optimum solution. This contains paired comparisons between each criterion, the outcomes of which show the choice task's total ranking. There are many features of the AHP. One of them is to generate numerical priority from the paired comparison matrix estimates, which expresses subjective knowledge (Alsuwehri, 2011). The method is useful in evaluating suppliers' weights in marketing or ranking order. However, it is difficult to determine the suitable weight and order of each alternative. It has been demonstrated that varying object weights produce various ranking outcomes (Liu and Hai, 2005).

For multicriteria decision-making, AHP is used by numerous international researchers. For instance, Kurt and Yazıcıoğlu's study from 2021 employs the AHP and TOPSIS Methodology to choose a competitive strategy for retail E-commerce (Kurt and Yazıcıoğlu, 2021). AHP was also used in the study conducted by Thresia and Cakravastia (2021) regarding the Supplier Selection Criteria for E-Commerce Based Fashion SMEs to determine the weights of the criteria and sub-criteria in the hierarchical structure framework (Yoan Thresia and Cakravastia, 2021). The same model was formulated and applied in the study of Alsuwehri (2011) for the supplier selection and evaluation of a water industry company.

In addition to the previous research, Ocampo and Clark's study, which used AHP as a strategy, looked at sustainable manufacturing strategies for a semiconductor manufacturing company in the Philippines (Ocampo and Clark, 2015). In this study, the sustainable manufacturing initiatives of FC Semiconductor were evaluated with their degree of relevance to sustainability using the hierarchical framework of Joung et al. (2013) (Joung *et al.*, 2013). Five sustainable manufacturing initiatives were presented for evaluation: health and wellness programs, competitive employee compensation and career development, sound occupational health and safety program, elimination of lead (Pb) in the plating process, and lean six sigma programs.

Although several published works on applying AHP for multi-criteria decision-making have already been done, the selection of suppliers for an e-commerce company based in the Philippines is nonexistent. This study aims to employ AHP for supplier selection and assessment in a Philippine-based online retailer for the new product it intends to release. All prospective suppliers were providers of the business's other goods, and they were all based in China. The firm initially selects the supplier who provides the most competitive cost per unit of product. However, it is not necessarily the only consideration. In the company's last product launch, for instance, they chose the supplier with the lowest product cost but encountered many unfavorable reviews owing to the quality difficulties, which harmed the brand's credibility. It is challenging for the business to restock the shelves because some suppliers with low product costs also have slower production times. The management is now searching for a supplier in a more methodical way as a result of these results.

## 2. METHODOLOGY

The utilization of a model is vital in the implementation of the Analytic Hierarchy Process (AHP) for the purpose of selecting the most optimal supplier. The methodology employed in this study draws upon the strategy outlined in the work of Alsuwehri (2011). The subsequent procedures may be implemented by an unidentified Philippine-based E-commerce enterprise in the selection of a suitable supplier for the next product it intends to introduce.

### Step 1: Define criteria for supplier selection.

In this step, the researchers decide on the appropriate criteria for judging the supplier based on the available literature and their own judgment. Five crucial factors were chosen from the criteria utilized in the previous studies (Alsuwehri, 2011; Rouyendegh and Erkan, 2011; Yoan Thresia and Cakravastia, 2021).

The selection of the top five criteria was conducted subsequent to the assessment of the criteria using a four-category scale ranging from Not Important (1 to 3), Somewhat Important (4 to 5), Important (6 to 7), and Very Important (8 to 9). (Tam and Tummala, 2001). Finally, the five main criteria selected are cost, quality, delivery, payment flexibility, and variety.

**Table 1.** The definition of selected criteria

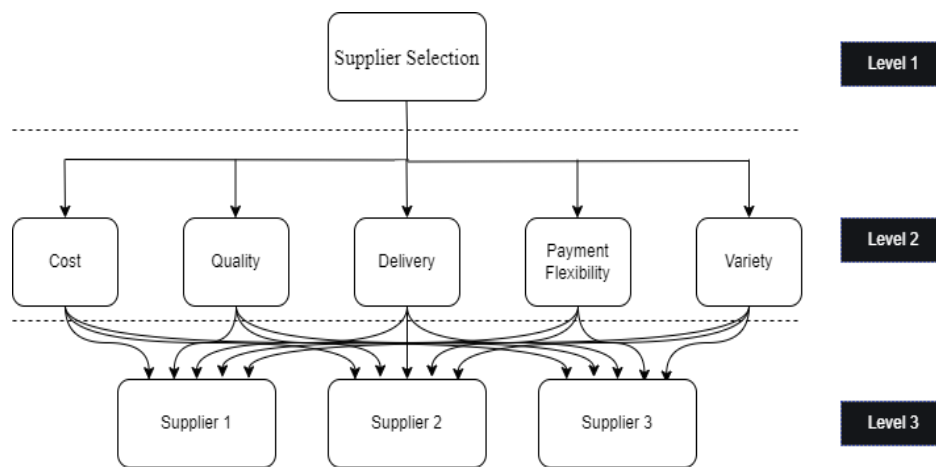
Criteria	Definition
Cost	The price paid or required for acquiring a service or a product. The cost is a monetary valuation of effort, material, resources, time, and utilities consumed.
Quality	The supplier's capacity to consistently meet quality requirements, which include features of high quality (material, dimensions, design, and durability), variety, production quality (production lines, machines used in manufacturing procedures), and quality system and continuous development.

Delivery	The supplier's capacity to fulfill orders in accordance with predetermined delivery schedules, which may include lead times, on-time performance, fill rates, returns management, locations, transportation, and incoterms.
Payment Flexibility	The ability of a supplier to adjust and give terms according to customer's current resources and availability of payment mode
Variety	The ability of a supplier to provide choices and options that will cater the needs of the customer

**Step 2: Structure the hierarchical model**

This stage encompasses the development of the Analytic Hierarchy Process (AHP) hierarchy model and the computation of the weights assigned to each level within the supplier selection model. The AHP model that was developed consists of three hierarchical levels: the goal, the criteria, and the alternatives. The criteria and sub-criteria used in this model are established based on known factors.

Figure 1 shows an illustrative three-level hierarchy for the supplier selection problem. The goal, which is to choose the best supplier for an online retailer situated in the Philippines, is the first level of the hierarchy. Cost, quality, delivery, payment flexibility, and diversity are included in the second level (criteria). The alternatives, or various providers to be compared in order to choose the best supplier, are contained in the hierarchy's lowest level.



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**Figure 1.** Analytical Hierarchy Process Flowchart

To find the priority weight for each criterion, a pair-wise comparison was conducted. The researchers surveyed the Head of Supply Chain and Logistics of an unknown Philippine-based E-commerce company based on how she thinks of the importance of one criterion as compared to the other for their company. The respondent was chosen as an expert because she has more than 15 years of experience in Supply Chain and has been in the said company for more than a year. Among the other Heads of the company, she is also the one with the most coordination with the suppliers.

As shown in Table 1, a pair-wise comparison is a method used to determine the relative importance of the criteria and sub-criteria. Saaty (1980) suggested a nine-point scale to describe the amount of relative importance. This scale assigns values of 1, 3, 5, 7, and 9 to represent equal, moderate, strong, extremely strong, and extreme levels of importance, respectively. The values 2, 4, 6, and 8 were employed as intermediate values between two adjacent parameters.

**Table 2.** The scale of Relative Importance  
Source: Saaty (1980)

Intensity of importance	Degree of preference	Explanation
1	Equally	Both requirements hold equal importance.
3	Moderately	One criterion holds a somewhat higher level of importance compared to the other.
5	Strongly	One criterion has much more importance in comparison to the other.

7	Very Strongly	One criterion exhibits significantly greater importance than the other.
9	Extremely	One criterion holds significantly greater importance than the other.
2,4,6,8	Intermediate values	When compromise is needed

To assist in calculating the priority weights of each criterion, the researchers employed the Super Decisions software which is based on Analytic Hierarchical Process (AHP) and Analytic Network Process (ANP) methods. These methods allow for the consideration of intangibles in decision making process. The AHP/ANP methodology is widely recognized as the most efficient strategy for integrating subjective judgment with objective information in order to evaluate options and predict outcomes effectively.

The calculation of the consistency ratio (C.R.) was performed in order to assess the validity of the priority weighting. The consistency test is a fundamental aspect of the Analytic Hierarchy Process (AHP) methodology. Its purpose is to identify and address any potential inconsistencies in the weights assigned to criterion. This is achieved by calculating the consistency level of each matrix. The utilization of the consistency ratio (CR) was employed to evaluate and provide a rationale for the incongruity observed in the pair-wise comparison conducted by the participants. Based on the empirical proposal provided by Saaty in 1980, which states that a consistency ratio (C.R.) of 0.10 is deemed acceptable, it may be inferred that the previous pair-wise comparisons conducted to determine attribute weights exhibit a reasonable level of consistency. If the coefficient of reproducibility (CR) is below the predetermined threshold, the weight measurements can be deemed as legitimate and consistent. On the other hand, in cases where the consistency ratio (CR) exceeds the predetermined threshold, the matrix outcomes exhibit inconsistency and are consequently excluded from subsequent analysis. In this study, the computation of the Consistency Ratio was automated by the utilization of the Super Decisions Software.

### Step 3: Measure Supplier Performance

The subsequent stage involves the assessment of various suppliers based on the employed model in order to determine the most optimal supplier. In this step, the researchers asked the respondent, the Head of the supply chain of that unknown E-commerce company about how she preferred one supplier as compared to the other for each criterion. A questionnaire was sent to the respondent and a matrix was also created based on the responses provided. The Super Decisions Software was utilized for the calculation of the weights assigned to each choice and the determination of the consistency ratio.

Step 4: Identify supplier priority and supplier selection.

Based on the priority weights of each criterion and the rating of each alternative in relation to each criterion, the weights of each alternative (supplier) were computed. The alternative with the highest weight was considered to be selected as the supplier for the new product the E-commerce company will launch.

## 3. RESULT AND DISCUSSION

### Structure the hierarchical model

Table 3 below shows the pair-wise comparison matrix created based on the response of the respondent on the questionnaire provided. The provided entry for the five rows and the five columns illustrates the significance of each row's criterion in relation to the column's criterion, as shown.

**Tabel 3.** Pair-wise comparison matrix of the criteria

Criteria for Supplier Selection	Cost	Quality	Delivery	Payment Flexibility	Variety
Cost	1	2	5	4	7
Quality	1/2	1	4	5	6
Delivery	1/5	1/4	1	2	3
Payment Flexibility	1/4	1/5	1/2	1	4
Variety	1/7	1/6	1/3	1/4	1

It is evident that the cost criterion carries greater significance compared to the remaining criteria. The initial row functions as an illustrative instance of how the cost weight exhibits a favorable comparison to the other weights. For instance, the cost criterion is chosen by a factor of 2, followed by delivery by a factor of 5, payment flexibility by a factor of 4, and diversity by a factor of 7. The criterion for the second row and column, which is quality, holds greater significance in determining a good performance compared to payment flexibility and variety (as evidenced by the values

of 5 and 6 respectively). Furthermore, a good performance on delivery holds a moderately higher level of importance than payment flexibility and variety. The diagonal elements are given a value of 1, as delivery (row) is equally desired.

Super Decisions Software was used for the computation of weighting of elements in the matrix. The network was first created in the software which consists of one goal (supplier selection), five criteria (cost, quality, delivery, payment flexibility and variety) and three alternatives (supplier 1, supplier 2 and supplier 3). Figure 2 below shows the result of the computation of priority weights and consistency ratio.

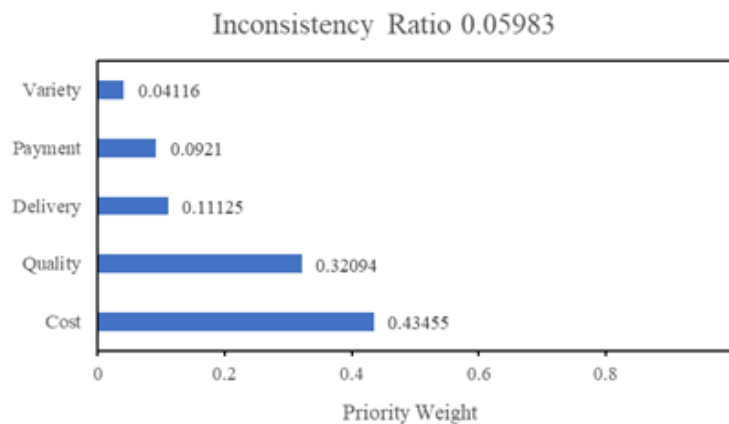


Figure 2. Computation of Priority Weights and Consistency Ratio

Among the five elements, cost criteria are the highest, having the priority weight of 0.435. The second most important criteria are quality having a priority rating of 0.32, followed by delivery and payment flexibility with priority weights 0.111 and 0.092 respectively. Lastly, variety criteria were found to be least priority having the rating of 0.041.

The consistency ratio (C.R.) for the comparison of the criteria was computed to be 0.06. According to Saaty's (1980) empirical recommendation, a consistency ratio (C.R.) of 0.10 is deemed adequate. If the coefficient of reproducibility (CR) is below the threshold value, the weight measurements can be considered genuine and reliable. On the other hand, when the consistency ratio (CR) exceeds the predetermined threshold, the matrix outcomes exhibit inconsistency and are therefore excluded from subsequent analysis. Hence, given that the coefficient of correlation (C.R) is below 0.1, it can be concluded that the judgements are deemed acceptable (Al-Harbi, 2001).

**Measure Supplier Performance**

Super Decisions Software was used to calculate the weight of each alternative for each criterion and the consistency ratio. The figures below show the result of each alternative for each criterion. Figure 3 shows the comparison of suppliers for Cost criteria, Figure 4 shows the comparison of suppliers for Quality, Figure 5 shows the comparison of suppliers for Delivery criteria, Figure 6 shows the comparison of suppliers for Payment Flexibility criteria and finally, Figure 7 shows the comparison of suppliers for Variety criteria.

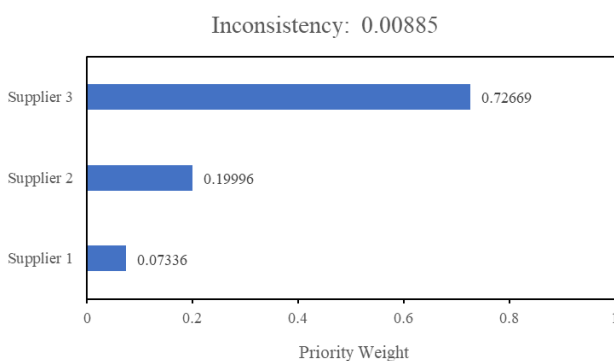


Figure 3. Comparison of suppliers for Cost criteria

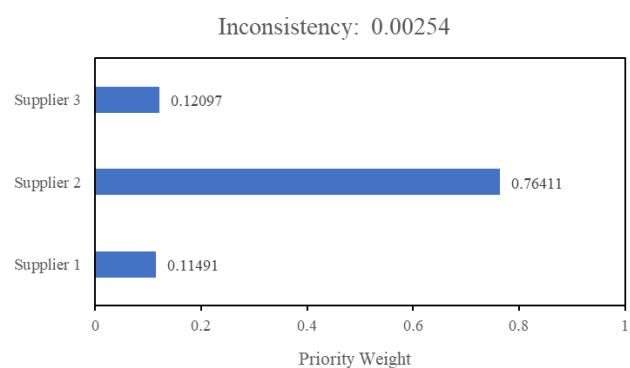


Figure 4. Comparison of suppliers for Quality criteria

Figure 3 shows that for the Cost criteria, Supplier 3 is most preferred having weight of 0.727. It is followed by Supplier 2 which has a weight and 0.2 while the least preferred is Supplier 1 with a weight of 0.073. The consistency ratio for the comparison of the alternatives in Cost criteria is found to be 0.009. This is less than 0.10, therefore, the judgments are acceptable. Figure 4 shows that for the Quality criteria, Supplier 2 is most preferred having weight of 0.764. It is followed by Supplier 3 having a weight and 0.121 while the least preferred is Supplier 1 with a weight of 0.115. The

consistency ratio for the comparison of the alternatives in Quality criteria is found to be 0.003. This is less than 0.10, therefore, the judgments are acceptable.

Figure 5 shows that for the Delivery criteria, Supplier 2 is most preferred having weight of 0.481. It is followed by Supplier 1, which has a weight and 0.463 while the least preferred is Supplier 3 with a weight of 0.056. The consistency ratio for the comparison of the alternatives to Delivery criteria is found to be 0.001. This is less than 0.10, therefore, the judgments are acceptable (Al-Harbi, 2001).

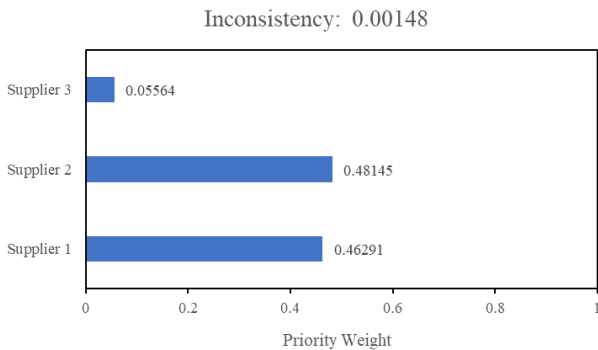


Figure 5. Comparison of suppliers for Delivery criteria

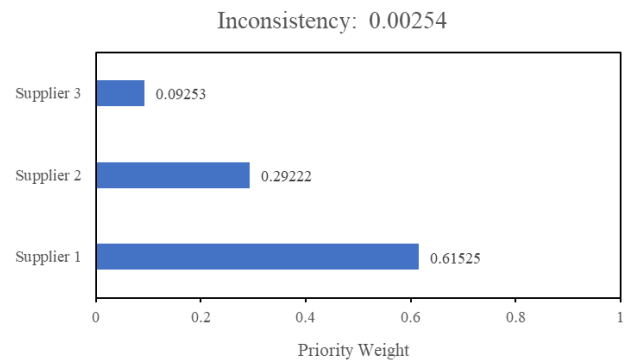


Figure 6. Comparison of suppliers for Payment Flexibility criteria

Figure 6 shows that for the Payment Flexibility criteria, Supplier 1 is most preferred having weight of 0.615. It is followed by Supplier 2 which has a weight and 0.292 while the least preferred is Supplier 3 with a weight of 0.09. The consistency ratio for the comparison of the alternatives in Payment Flexibility criteria is found to be 0.003. This is less than 0.10, therefore, the judgments are acceptable.

Figure 7 shows that for the Payment Flexibility criteria, Supplier 1 is most preferred having weight of 0.717. It is followed by Supplier 2 having a weight and 0.205 while the least preferred is Supplier 3 with a weight of 0.078. The consistency ratio for the comparison of the alternatives in Variety criteria is found to be 0.02. This is less than 0.10, therefore, the judgments are acceptable.

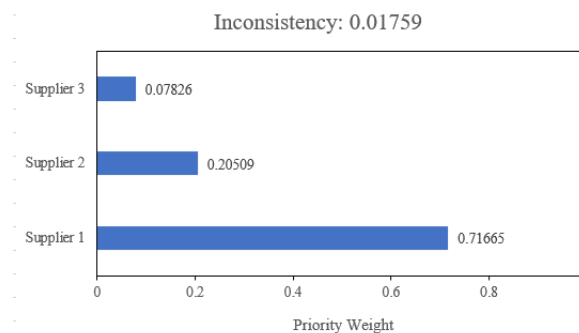


Figure 7. Comparison of suppliers for Variety criteria

**Measure Supplier Performance**

Figure 8 shows the Model Synthesis of the AHP Method using the Super Decision Software. It is important to note that, when compared with the three suppliers provided, supplier 2 exhibits the greatest score. As can be seen, supplier 2's score of (0.421) is greater than the other two suppliers' scores such as supplier 1 (0.206), and supplier 3 (0.373). Hence, Supplier 2 might potentially be deemed the optimal choice as the preferred supplier for the unknown Philippine-based E-commerce company for the new product it is planning to launch. The results of this research are in line with research conducted by Cengiz at all, which also used super decision software to select the best supplier. (Cengiz *et al.*, 2017)

Name	Graphic	Ideals	Normals	Raw
1Supplier 1		0.490271	0.206423	0.103212
2Supplier 2		1.000000	0.421039	0.210520
3Supplier 3		0.884805	0.372538	0.186269

Figure 8. Result of the AHP method

#### 4. CONCLUSION

This study suggests using AHP as a methodology to evaluate and choose three suppliers for one Philippine e-commerce site. Cost, quality, delivery, payment flexibility, and variety make up the decision-making criteria. AHP has investigated how well each provider performed in relation to each criterion in order to develop a framework for formalizing the comparison of the various suppliers' offerings' conflicting selection criteria. To aid in the estimation of the priority weights of each criterion, we employed super decision software. As a consequence, supplier 2 received a score of 0.421, making it the best provider out of Suppliers 1 and 3. By keeping an eye on and analyzing suppliers' actual performance from a subjective standpoint, this assessment program can address the act of purchasing the necessities. It explains the defined topics' purchasing priorities in an understandable manner to the provider. In the real world, managers must carefully choose the variables that best reflect their competitive priorities, targets, and goals. They must also create pair-wise comparison matrices.

#### 5. ACKNOWLEDGMENT

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