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Decision Support System for Extending PT Nitro Pratama Indonesia Outlet Cooperation Using the Fuzzy AHP-TOPSIS

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ABSTRACT

The increasingly competitive business environment requires companies to make objective decisions, particularly in evaluating outlet contract extensions. PT Nitro Pratama Indonesia previously relied on manual, subjective assessments that often led to inconsistent outcomes. This study developed a web-based decision support system to support renewal decisions systematically. The system applies a combination of Fuzzy Analytical Hierarchy Process (Fuzzy AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS): Fuzzy AHP determines criterion weights under uncertainty, while TOPSIS ranks alternatives by their closeness to the ideal solution. A total of 50 active outlets from the Surabaya and Solo branches were evaluated using six criteria: Outlet Revenue (0.33), Rental Cost (0.26), Location (0.16), Accessibility (0.11), Competitiveness (0.08), and Operational Cost (0.06). The ranking process produced objective recommendations consistent with manual calculations. Functional testing with the Black Box method confirmed that all system features—data input, weight calculation, ranking, and recommendations—operated properly. Usability testing involving prospective users yielded positive results, with average scores of 4.3–4.6 across ease of use, clarity of information, and perceived usefulness. These findings demonstrate that the system is both technically reliable and practically effective in supporting accurate and efficient decision-making for outlet contract extensions.

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1. Introduction

The increasingly competitive business landscape requires companies to make precise, objective, and measurable decisions to sustain operations [1]. A particularly critical strategic decision concerns whether to renew or terminate partnerships, as such choices directly affect operational stability and the continuity of a firm's partnership network [2]. For firms collaborating with multiple partners, renewal decisions are especially challenging because they must simultaneously support business sustainability and growth. PT Nitro Pratama Indonesia, a provider of nitrogen filling services and automotive products, faces the same challenge in assessing the feasibility of outlet contract extensions [3]. The current evaluation process remains manual and subjective, relying on managerial intuition and experience. Although intended to ensure that each outlet continues to meet prescribed standards, this approach introduces risks of inaccuracy and inconsistency for instance, the renewal of low performing outlets thereby reducing resource efficiency.

A Decision Support System (DSS) is defined as a computer-based system that assists decision-makers by utilizing data and models to address complex and unstructured problems. Compared with subjective manual approaches, a DSS enables more systematic, measurable, and data driven analysis [4][5][6]. In this study, a DSS was developed by combining the Fuzzy Analytical Hierarchy Process (Fuzzy AHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). Fuzzy AHP flexibly derives criterion weights under uncertainty [7], while TOPSIS ranks alternatives based on proximity to the positive ideal solution and distance from the negative ideal solution [8]. The dataset used in this research comprised 50 active outlets across the Surabaya and Solo branches, which were evaluated against six criteria: rental cost, outlet revenue, outlet location, accessibility, operational cost, and competitiveness.

Previous studies have demonstrated that Fuzzy AHP improves efficiency and transparency by capturing linguistic uncertainty, while also producing more accurate and stable weights than conventional AHP [9][10][11][12]. Meanwhile, Studies on web-based TOPSIS confirm that it delivers results consistent with manual calculations and is effective in ranking alternatives, with advantages in conceptual simplicity and evaluation based on proximity to ideal solutions [13][14][15]. Research combining AHP and TOPSIS achieved recommendation accuracy up to 84.21% [8], yet most of these still relied on conventional AHP rather than Fuzzy AHP [16]. Beyond these methods, several alternatives such as SAW and MOORA are also widely used. SAW is simple to apply but highly sensitive to variations in criterion weights [17]; and MOORA offers robust multi-criteria handling with computational simplicity, yet it is sensitive to normalization issues and less effective in dealing with uncertainty [18]; Compared to these, the Fuzzy AHP TOPSIS combination captures uncertainty during weighting and produces rankings consistent with an ideal-solution perspective, making it highly suitable for outlet contract evaluation.

The novelty of this work lies in three contributions. First, applying the combined Fuzzy AHP TOPSIS to outlet contract renewal decisions, which remains underexplored in the literature. Second, integrating the methods into a dynamic web-based system that automatically updates evaluation outcomes whenever input data change. Third, introducing managerial thresholds—namely a decision threshold and a crisis boundary—that translate numerical scores into actionable recommendations by classifying outlets into extend, review, or not recommend. Consequently, the proposed system is expected to support more accurate, transparent, and efficient decision-making, while also offering practical value for PT Nitro Pratama Indonesia in managing its outlet cooperation.

2. Research Method

This section outlines the stages undertaken in this study.

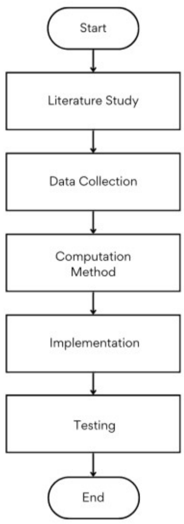

Figure 1. Research Method

As shown in Figure 1, the study began with a literature review. The literature review is a key stage that synthesizes credible sources (journals, books, and other relevant references) to map the theoretical foundations, assess prior findings, identify the research gap, and formulate an appropriate methodology and coherent arguments for this thesis.

2.1. Data Collection

Data collection constituted the foundational stage of this study. To elicit user needs and business constraints, we conducted an intensive, semi-structured online interview with a representative of PT Nitro Pratama Indonesia's central management. The protocol explored pain points in the current outlet-evaluation process, decision factors and their measurement orientation (benefit/cost), and expectations for applying Fuzzy AHP–TOPSIS to achieve more objective and measurable decisions. Interview outputs were thematically analyzed to derive and operationalize the evaluation criteria and indicators. This dual-source strategy ensured that subsequent modeling aligned with actual managerial priorities and reflected the firm's operational data conditions.

2.2. Computation Method

This study employed a combination of two multi-criteria methods, namely Fuzzy AHP and TOPSIS. Fuzzy AHP was used to derive criterion weights while accounting for data uncertainty [7], whereas TOPSIS was used to rank alternatives based on their proximity to the positive ideal solution [8].

2.2.1 Fuzzy AHP

Fuzzy Logic is a computational method developed to handle uncertainty and vagueness in decision-making, particularly when the available data are subjective or linguistic in nature. The concept of fuzzy sets was formalized in the 1960s by Zadeh in the theory of fuzzy sets and Dempster. The Dempster–Shafer theory is regarded as a generalization of probability theory, where elements of the sample space are associated with probability masses that are not necessarily zero or single-point values but may instead be distributed across multiple sets[19].

The Fuzzy Analytical Hierarchy Process (Fuzzy AHP) integrates the AHP method with fuzzy logic. This approach refines classical AHP for problems in which criteria exhibit a high degree of subjectivity. Fuzzy AHP aims to address AHP's limitations in handling subjectivity and uncertainty [19]. Pairwise comparison values in Fuzzy AHP differ from those in standard AHP: whereas AHP uses the 1–9 fundamental scale, Fuzzy AHP applies Triangular Fuzzy Number (TFN) membership functions [20], as shown in Table 1.

Table 1. Triangular Fuzzy Number [21]

AHP Scale	Linguistic Scale	Fuzzy Scale	Invers Fuzzy
1	Equal importance	(1, 1, 1)	(1, 1, 1)
3	Slightly more important	(2, 3, 4)	(1/4, 1/3, 1/2)
5	More important	(4, 5, 6)	(1/6, 1/5, 1/4)
7	Strongly more important	(6, 7, 8)	(1/8, 1/7, 1/6)
9	Absolutely more important	(8, 9, 9)	(1/9, 1/9, 1/8)

The stages in implementing the Fuzzy AHP method developed by Chang (1996) [22] are as follows:

1. Construction of the pairwise comparison matrix
2. Computation of the Fuzzy Synthetic Extent
3. Computation of the Degree of Possibility
4. Computation of the priority weights (weight vector)
5. Normalization of the weights

The detailed mathematical formulations of each stage are presented in Appendix A.

2.2.2 TOPSIS

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is a method first introduced by Hwang and Yoon in 1981. TOPSIS is defined as a multi-criteria decision-making method that evaluates alternatives by minimizing the distance to the positive ideal solution and maximizing the distance from the negative ideal solution. TOPSIS is one of the Multi-Attribute Decision Making (MADM) methods, alongside AHP [6].

The implementation stages of TOPSIS are as follows [6]:

1. Construct the decision matrix
2. Normalize the decision matrix
3. Form the weighted normalized decision matrix
4. Compute the distances to the ideal solutions
5. Compute the relative preference value

The complete computational formulas for TOPSIS are also provided in Appendix B.

2.3. Implementation

The proposed decision model is operationalized as a web-based Decision Support System that runs the Fuzzy AHP–TOPSIS pipeline and presents outlet renewal recommendations through an accessible browser interface. The web application supports data entry, criteria weight input, automated computation, and results visualization for authorized users (e.g., central management and area managers). Deploying it on the web ensures easy access, timely updates when inputs change, and straightforward maintenance without requiring local installations.

2.4 Testing

System testing was conducted through two approaches. Functional testing using the Black Box method verified that key features—such as data input, criteria weighting, alternative ranking, and decision recommendations—operated as expected. In designing the testing scheme, the Guttman scale was applied, which is a cumulative scale suitable for dichotomous responses such as “Success–Failure,” allowing each feature to be evaluated with clear and decisive outcomes [23]. In addition, usability evaluation involving PT Nitro Pratama Indonesia’s end users was carried out using a 5-point Likert scale to assess ease of use, clarity of information, and perceived usefulness. These tests ensured that the system was not only technically reliable but also practical and user-friendly in supporting outlet contract renewal decisions.

3. Result and Discussion

3.1. Planning

At this stage, an initial study plan was formulated from prior stakeholder communications, particularly semi-structured interviews with PT Nitro Pratama Indonesia. The objective was to define the preliminary framework of the decision support system through a comprehensive understanding of the problem context. The phase comprised problem identification, analysis and operationalization of evaluation criteria, and a preliminary analysis of alternatives.

Problem identification showed that PT Nitro Pratama Indonesia’s outlet contract-renewal process was still manual and subjective, relying on managerial intuition when considering factors such as rental cost, revenue, location, operational cost, and competitiveness, before categorizing outlets as “prospective” or “not prospective.” This workflow often reduced validity and reliability, leading to potential inefficiency and suboptimal decisions. To address these issues, a Decision Support System was proposed at the evaluation stage, integrating Fuzzy AHP to determine criterion weights under uncertainty and TOPSIS to rank alternatives transparently and consistently. Managerial inputs and operational evidence confirmed six key criteria—rental cost, outlet revenue, location, accessibility, operational cost, and competitiveness—which serve as the basis for the decision model summarized in Table 2.

Table 2. Criteria

No	Criteria Name	Criteria Code	Criteria Type
1	Rental costs	K01	Benefit
2	Outlet revenue	K02	Cost
3	Location	K03	Benefit
4	Accessibility	K04	Benefit
5	Operating costs	K05	Cost
6	Competitiveness	K06	Benefit

Next, information on all currently active outlets was compiled to define the decision alternatives. The dataset, drawn from the company's internal records, covered two operating areas—Surabaya and Solo. This collection formed the basis for alternative identification: each listed outlet served as an evaluation object to be compared against the predefined criteria. The complete set of alternatives is presented in Table 3.

Table 3. Alternative

No	Alternative Name	Branch	Alternative Code
1	Outlet Surabaya 01	Surabaya	SBY01
2	Outlet Surabaya 02	Surabaya	SBY02
3	Outlet Surabaya 03	Surabaya	SBY03
4	Outlet Surabaya 04	Surabaya	SBY04
5	Outlet Surabaya 05	Surabaya	SBY05
6	Outlet Surabaya 06	Surabaya	SBY06
7	Outlet Surabaya 07	Surabaya	SBY07
8	Outlet Surabaya 08	Surabaya	SBY08
9	Outlet Surabaya 09	Surabaya	SBY09
10	Outlet Surabaya 10	Surabaya	SBY10
11	Outlet Surabaya 11	Surabaya	SBY11
12	Outlet Surabaya 12	Surabaya	SBY12
13	Outlet Surabaya 13	Surabaya	SBY13
14	Outlet Surabaya 14	Surabaya	SBY14
15	Outlet Surabaya 15	Surabaya	SBY15
16	Outlet Surabaya 16	Surabaya	SBY16
17	Outlet Surabaya 17	Surabaya	SBY17
18	Outlet Surabaya 18	Surabaya	SBY18
19	Outlet Surabaya 19	Surabaya	SBY19
20	Outlet Solo 01	Solo	SLO01
21	Outlet Solo 02	Solo	SLO02
22	Outlet Solo 03	Solo	SLO03
23	Outlet Solo 04	Solo	SLO04
24	Outlet Solo 05	Solo	SLO05
25	Outlet Solo 06	Solo	SLO06
26	Outlet Solo 07	Solo	SLO07
27	Outlet Solo 08	Solo	SLO08
28	Outlet Solo 09	Solo	SLO09
29	Outlet Solo 10	Solo	SLO10
30	Outlet Solo 11	Solo	SLO11
31	Outlet Solo 12	Solo	SLO12
32	Outlet Solo 13	Solo	SLO13
33	Outlet Solo 14	Solo	SLO14
34	Outlet Solo 15	Solo	SLO15
35	Outlet Solo 16	Solo	SLO16
36	Outlet Solo 17	Solo	SLO17
37	Outlet Solo 18	Solo	SLO18
38	Outlet Solo 19	Solo	SLO19
39	Outlet Solo 20	Solo	SLO20
40	Outlet Solo 21	Solo	SLO21
41	Outlet Solo 22	Solo	SLO22
42	Outlet Solo 23	Solo	SLO23
43	Outlet Solo 24	Solo	SLO24
44	Outlet Solo 25	Solo	SLO25
45	Outlet Solo 26	Solo	SLO26
46	Outlet Solo 27	Solo	SLO27
47	Outlet Solo 28	Solo	SLO28
48	Outlet Solo 29	Solo	SLO29
49	Outlet Solo 30	Solo	SLO30
50	Outlet Solo 31	Solo	SLO31

3.2. Computation Method

After all criteria and alternatives were analyzed, manual computations using the Fuzzy AHP–TOPSIS method were performed. These calculations aimed to obtain the criterion weights and the alternative rankings that serve as the basis for decision making.

3.2.1 Fuzzy AHP Method

Based on the Fuzzy AHP results in Table 4, all normalized values are proportional; therefore, their sum equals 1. This indicates that the relative weights of each alternative have been standardized.

Table 4. Criteria weight results

No	Criteria Name	Criteria Weight
1	Rental costs	0,26
2	Outlet revenue	0,33
3	Location	0,16
4	Accessibility	0,11
5	Operational cost	0,06
6	Competitiveness	0,08

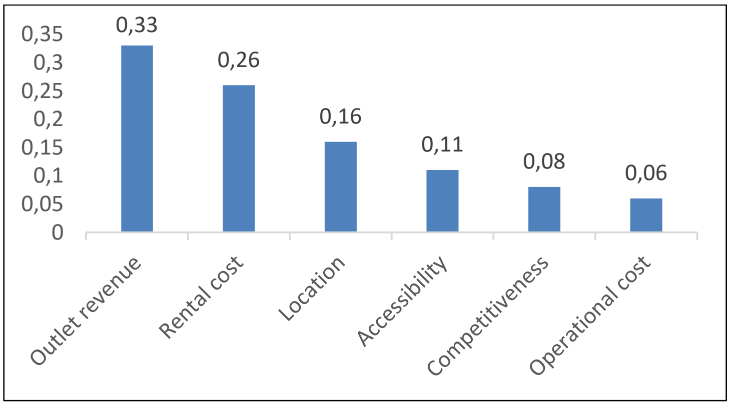

Figure 2. Graphical Comparison of Criteria Weights

Figure 2 illustrates the graphical distribution of the calculated criteria weights derived from the analytical assessment. The figure provides a visual representation of how each variable contributes to the overall decision-making model. Based on the weighting results, outlet revenue, with a value of 0.33, emerges as the most dominant factor. This indicates that revenue performance plays a critical role in determining the optimal outlet selection, as it directly reflects the financial return and long-term sustainability of the business. The second most influential criterion is rental cost, assigned a weight of 0.26. This suggests that the financial burden associated with leasing a commercial space significantly affects feasibility considerations, especially in competitive retail environments where cost efficiency remains essential.

Location, weighted at 0.16, ranks third in priority. Although location is typically regarded as a central consideration in many commercial studies, its relatively moderate weight in this analysis implies that it supports decision-making but does not outweigh the importance of potential revenue or rental expenses. This may reflect the specific characteristics of the dataset or the strategic priorities defined within the research context. The final criterion, operational cost, carries the lowest weight of 0.06. Its minimal contribution indicates that daily operational expenditures, while still relevant, do not substantially influence the model's overall evaluation compared to the other factors.

3.2.2 TOPSIS Method

The final ranking of alternatives was obtained using TOPSIS by comparing distances to the positive and negative ideal solutions. Based on the Surabaya branch ranking (Table 5), the highest-ranked was Outlet Surabaya 05, while Outlet Surabaya 19 had the lowest rank. Meanwhile, the Solo branch ranking (Table 6) showed Outlet Solo 29 as the highest-ranked and Outlet Solo 17 as the lowest.

Table 5. Ranking results for Surabaya branch

Alternative Name	Score	Rank
Outlet Surabaya 05	0.9264	1
Outlet Surabaya 16	0.9103	2
Outlet Surabaya 08	0.9021	3
Outlet Surabaya 13	0.8947	4
…		
Outlet Surabaya 19	0.1665	19

Table 6. Ranking results for Solo branch

Alternative Name	Score	Rank
Outlet Surabaya 05	0.9264	1
Outlet Surabaya 16	0.9103	2

Alternative Name	Score	Rank
Outlet Surabaya 08	0.9021	3
Outlet Surabaya 13	0.8947	4
…		
Outlet Surabaya 19	0.1665	19

The results of outlet ranking in this study reaffirm the effectiveness of the Fuzzy AHP–TOPSIS method. As evidenced by prior research [7], this hybrid approach has consistently yielded outputs compatible with manual evaluations and expert assessments in other domains. Such consistency underscores the robustness of Fuzzy AHP–TOPSIS, with this work contributing novelty through its application in the context of outlet contract renewal.

3.3. Implementation

3.3.1 System

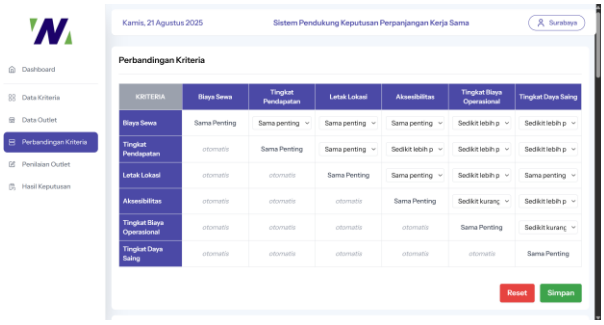

Figure 3. View of Criteria Weighting Page

Figure 3 presents the interface of the criteria weighting page used in the decision support system. This page displays each criterion along with its assigned weight, enabling users to review, adjust, and validate the relative importance of factors. The layout supports transparent, systematic, and reproducible weighting in the research process.

Figure 4. View of Criteria Weighting Results Page

Figure 4 displays the results page for criteria weighting, showing the final computed weights for each factor after processing. This page provides a clear summary of the priority order and numerical values, allowing users to interpret the outcomes easily, verify accuracy, and proceed to the next stage of the decision-making analysis.

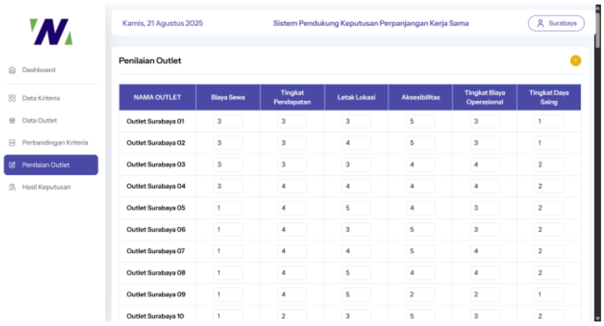

Figure 5. View of Outlet Rating Page

Figure 5 shows the outlet rating page, where users input or review performance scores for each outlet based on predefined criteria. This page supports systematic data entry, ensuring consistency and accuracy. The interface helps users compare outlets objectively and prepares the dataset for further processing within the decision-making system.

Figure 6. View of Outlet Rating Results Page

Figure 6 displays the outlet rating results page, presenting the computed scores for each outlet after all criteria have been processed. This page summarizes performance outcomes clearly, allowing users to compare alternatives objectively, verify rating accuracy, and identify the most optimal outlet based on the decision-making model applied in the system.

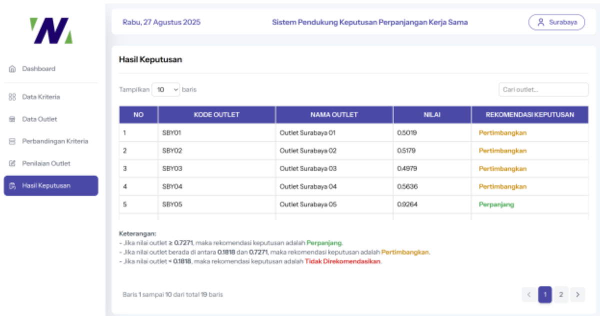

Figure 7. View of Decision Results Page

Figure 7 presents the decision results page, showing the final ranking of outlets based on calculated scores from all criteria. This page provides a clear summary of the optimal alternative, enabling users to interpret outcomes efficiently, confirm the decision-making process, and utilize the results to support strategic business or operational planning.

3.3.2 System Recommendations

Table 7. System Recommendation for Surabaya branch

Alternative Name	Score	Recommendation
Outlet Surabaya 05	0.9264	Extend
Outlet Surabaya 16	0.9103	Extend

Alternative Name	Score	Recommendation
Outlet Surabaya 08	0.9021	Extend
Outlet Surabaya 13	0.8947	Extend
…		
Outlet Surabaya 19	0.1665	Not Recommended

From Table 7, in the Surabaya branch there are 12 outlets recommended for a "Extend" decision. There are 6 outlets recommended for "Review" but still with a strong chance of renewal. Only Outlet Surabaya 19 is "Not Recommended" for renewal because its preference score is far below the decision threshold, at 0.1665.

Table 8. System Recommendation for Solo branch

Alternative Name	Score	Recommendation
Outlet Surabaya 05	0.9264	Extend
Outlet Surabaya 16	0.9103	Extend
Outlet Surabaya 08	0.9021	Extend
Outlet Surabaya 13	0.8947	Extend
…		
Outlet Surabaya 19	0.1665	Not Recommended

Based on Table 8, in the Solo branch there are 19 outlets recommended for "Extend". There are 11 outlets recommended for "Review" but still with a considerable chance of renewal. Only Outlet Solo 17 is "Not Recommended" for renewal because its preference score is far below the decision threshold, at 0.0996.

3.4 Testing

3.4.1 Functional Testing

Table 9. Functional Testing Results

No	Feature	Status
1	Manage kriteria data	Success
2	Manage outlet data	Success
3	Weight calculation (Fuzzy AHP)	Success
4	Alternative ranking (TOPSIS)	Success
5	Recommendation output	Success

Functional testing was carried out using the Black Box Testing method on all system features, including data input, criteria weighting, alternative ranking, and decision recommendation. Each scenario was tested against its expected outcome, as summarized in Table 9. All features worked as designed, with test cases producing correct outputs such as valid criteria weights, accurate ranking results, and appropriate decision recommendations. These results indicate that the system is functionally reliable and ready for managerial use.

3.4.2 Usability Testing

Table 10. Usability Testing Results

Indicator	Average Score	Interpretation
Ease of use	4.5	Very good
Clarity of information	4.3	Good
Perceived usefulness	4.6	Very good

The usability evaluation was conducted with prospective users of PT Nitro Pratama Indonesia, representing the three main roles of the system: General Manager and Branch Administration staff. As presented in **Table 10**, the evaluation produced an average score of 4.5 for ease of use, 4.3 for clarity of information, and 4.6 for perceived usefulness. Respondents emphasized that the system was simple to operate, provided information in a clear format, and delivered recommendations that were highly beneficial for managerial decision-making. Negative statements, such as the system being confusing or inconsistent, consistently received very low scores (1–2), further confirming the system's reliability. These results demonstrate that the developed decision support system is not only accurate in its computations but also user-friendly, practical, and relevant across different managerial roles in supporting outlet contract renewal decisions.

4. Conclusion

Based on the findings of this study, it can be concluded that the Decision Support System using the Fuzzy AHP–TOPSIS method is capable of assisting PT Nitro Pratama Indonesia in determining outlet contract extension decisions in an objective, efficient, and accurate manner. The system is designed to process six main criteria—rental cost, outlet revenue, location, accessibility, operational cost, and competitiveness—so that the resulting evaluation covers all key factors influencing the feasibility of contract renewal. With its dynamic nature, the system can automatically update evaluation results whenever there are changes in input data or criterion weights, making it adaptive and responsive to real-time field conditions. The Fuzzy AHP method proved effective in representing the subjective judgments of decision-makers into more flexible and realistic criterion weights, while the TOPSIS method provided a consistent evaluation mechanism by ranking alternatives according to their closeness to the positive ideal solution and distance from the negative ideal solution. The integration of these two methods resulted in a system that not only functions as an evaluation tool but also as a strategic instrument that supports consistency and transparency in the decision-making process, thereby providing the company with a stronger basis for selecting outlets eligible for contract renewal and ensuring the sustainability of business relationships with partners.

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