Multi criteria decision making to determine the location of Via Laundry's branch

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ABSTRACT

Choosing the optimal business location is crucial for strategic planning and competitive advantage. Having successfully operated for three years, Via Laundry is expanding by opening a new branch. Business owners have determined several alternatives for this new branch's location, namely Transpark Djuanda Bekasi, Jakarta Garden City, and Harapan Indah. The purpose of this study is to select preferred location for the new branch by using multi-criteria decision making, which is AHP (Analytic Hierarchy Process) and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution). The criteria—population density, water cleanliness, rental costs, land area, access road convenience, and competitiveness level—were determined and weighted through discussions with business owner and his partner, as experts. Using AHP, the criteria were prioritized and weights assigned: population density (0.370), water cleanliness (0.249), rental costs (0.131), land area (0.103), access roads (0.093), and competitiveness (0.054). TOPSIS was then applied to these weights to evaluate the alternatives, resulting in preference values: Jakarta Garden City (0.3053), Harapan Indah (0.3624), and Transpark Djuanda Bekasi (0.8009). The highest preference value indicated Transpark Djuanda Bekasi as the recommended location for the new Via's Laundry branch.

1. Introduction

The laundry business has proliferated in various parts of the city. This business has great potential because it can answer market needs to wash clothes in a practical and clean manner. Several laundry business players have made a lot of penetration and business expansion which has resulted in a laundry business growth of around 50% during the period 2021 to 2022. Business growth has also occurred in Via Laundry, where over the past 2 years there has been an increase in sales (kg). Via Laundry is a business engaged in the service sector that offers washing clothes and the like. Currently, Via Laundry only has 1 place of business located in the Bekasi area. After 3 years of existence with a stable income, the business owner wants to expand his business by opening another branch. At the time of determining the location of the first branch business, business owners make judgments with personal judgments without using an analysis of criteria with a particular method. The owner of Via Laundry has conducted a survey of suitable branch locations and will choose the best location out of 3 available options. Competition in this business is also tight, especially in the area around the employee or student boarding houses. Opening a new branch certainly requires a sizable investment, therefore business owners don't want to make mistakes of determining the location of Via Laundry new branch.

Location decision making is not only important in terms of costs and profits, but also one part of a company's strategic planning which is a significant source of increasing competitive advantage (Önder & Yaşlioğlu, 2016). As a long-term investment, choosing a location for a business will have significant impact on business performance due to its considerable investment value (Sugiyanto et al., 2023).

Certain location factors must be identified, evaluated, and ranked as important tools in making these decisions (Fuskova et al., 2018). Various literature studies regarding site selection have been carried out, so that criteria can be identified from previous literature which are then adjusted to the business owner's criteria. The criteria used for selecting a business location include environmental, market, resources, infrastructure, and socio-economic conditions (Khairunnisa & Septiani, 2021). Whereas, according to Hanggita (2018), several factors that need to be considered in selecting a location are workforce, accessibility, facilities, market, energy, competition, and government regulations.

Decisions are activities of choosing alternatives that are carried out consciously with certain criteria in achieving a goal (Septiani & Triwulandari, 2022). Decisions can be taken using various methods, which are approaches so that the decisions taken can be more systematic, measurable, and capable of being accounted for in accordance with the supporting justifications (Septiani et al., 2022). Decision analysis needs to consider a series of criteria to choose the best alternative, therefore it is necessary to apply Multi-Criteria Decision Making (MCDM) which allows determining the effect of each criteria on the overall goal (Konstantinos et al., 2019). The two MCDM methods used in this research are the Analytical Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). The AHP method introduced by Thomas L. Saaty is a multi-criteria decision-making technique capable of decomposing complex problems in a multi-level hierarchical structure consisting of objectives, criteria and alternatives (Hakim & Putra, 2022). One of AHP's advantages is it can provide weighting between criteria with a pairwise comparison matrix. In addition, AHP is able to check consistency in assessing criteria or alternatives to reduce possible misjudgments. This method can cover the shortcomings of the TOPSIS method which does not have a qualitative data weighting step.

The purpose of this study was to determine the location of the Via Laundry business branch. The integration of the AHP and TOPSIS methods can be used to complement each other so that they have strength in the basis of weighting, consistency checking, and final weighting which would be more ideal because it is based on the ideal solution that might occur. A combination of the AHP and TOPSIS methods has been used to solve various problems, such as for evaluating hotel pages (Akincilar & Dagdeviren, 2014), determining micro business to receive funding support (Hanin et al., 2023), determining suppliers product components (Azwir et al., 2020), determination of the best parameters for green manufacturing (Singh et al., 2020), selection of recreational park locations related to science and technology (Druak et al., 2021), supplier selection (Muhammad et al., 2020), selection of marketplace preference (Jatiningrum et al., 2022), and selection of wind farm installation locations (Konstantinos et al., 2019).

2. Methods

The method used in making decisions for selecting Via Laundry branch location is the integration of AHP and TOPSIS. The research begins with identifying problems, determining research objectives, and collecting references from various sources regarding criteria, then proceed with collecting research data. The data obtained in this study is primary data by conducting interviews with two experts. In this study, the experts selected were business owners and their business partners, each of whom had been an entrepreneur for more than 6 years. Specifically in the laundry sector, the two experts have successfully run Via Laundry for more than 4 years with constant sales growth every year, so that business owners and colleagues are the right people to become experts in this research. The interview begins with a discussion regarding the problems encountered, the criteria that are considered by the owner in determining the location of the branch, alternative branch locations that have been determined, then a discussion and assessment is carried out regarding the level of importance of the criteria.

AHP is a qualitative analysis technique developed by Saaty, which discusses how to determine relative importance in multi-criteria decision-making problems. The AHP method is based on three principles, namely a hierarchical model structure, a pairwise comparison matrix of assessments between criteria or alternatives, and priority synthesis (Mondal et al., 2018). AHP is considered an inclusive method for making decisions with various criteria because it is able to adopt both quantitative and qualitative criteria (Taherdoost, 2017). Various decision-making techniques using the AHP method have been widely applied in the industrial world.

The steps of the AHP method are as follows:

1. Making a hierarchical structure that describes the decision to be taken, criteria, and decision alternatives.

2. Making a pairwise comparison matrix of the results of the assessment of the level of importance between criteria. Experts fill out questionnaires and provide ratings indicating a comparison of the level of importance between criteria. The values in the pairwise comparison matrix based on the AHP 1-9 rating scale can be seen in Table 1.

Table 1 Rating scale for pairwise comparison matrix (Saaty, 1980)

Intensity of Importance	Explanation
1	Judgement favors both criteria equally
3	Judgement slightly favors one criteria
5	Judgement strongly favors one criteria
7	One criteria is favored strongly over the other
9	There is evidence affirming that one criteria is favored over another
2,4,6,8	Immediate values between above scale values

3. Normalize the matrix by adding up each column and dividing the value in the matrix by the sum of each column.
4. Calculation of the priority vector value which is the weight of each criteria.
5. The calculation of λ max begins with the multiplication of the pairwise comparison matrices with the priority vector. The final value is obtained by dividing the multiplication result by the criteria weight, which is then averaged. The average result is the λ max value as in Equation (1).
$$\lambda_{max} = \sum_{j=1}^{n} a_{ij} \frac{W_j}{W_i} \quad (1)$$
6. The results of the assessment are declared consistent if the Consistency Ratio value is less than 0.1. Consistency testing begins by calculating the Consistency Index (CI) value with Equation (2) where n is the number of criteria.
$$CI = \frac{(\lambda\ maks - n)}{n-1} \quad (2)$$
Calculation of the Consistency Ratio (CR) value is done by dividing the Consistency Index (CI) value by the Random Index (RI) as shown in Equation (3).
$$CR = \frac{CI}{RI} \quad (3)$$

TOPSIS is a multi-criteria decision-making method that uses the principle that the chosen alternative must have the shortest distance from the positive ideal solution and the farthest from the negative ideal solution (Rahim et al., 2018). TOPSIS calculation steps are as follows:

1. Making a decision matrix.
2. Matrix normalization with a formula like Equation (4).
$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i-1}^{m} x_{ij}^2}} \; i = 1,2, \dots m, j = 1,2, \dots, n \quad (4)$$
3. Making a weighted decision matrix by multiplying the normalized matrix with the criteria weight (Equation (5)) based on the results of calculations using the AHP method.
$$v_{ij} = r_{ij} w_j \quad (5)$$
4. Determination of positive ideal solutions (A+) and negative ideal solutions (A-) for each criteria as shown in Equations (6) and (7).
$$A^* = \{(\max v_{ij} \,|j \epsilon J), (\min v_{ij} |j \epsilon J')\} \quad (6)$$
$$A^- = \{(\min v_{ij} \,|j \epsilon J), (\max v_{ij} |j \epsilon J')\} \quad (7)$$
5. Calculation of the distance between the values of each alternative and the positive and negative ideal solutions, which are denoted as D+ and D-, respectively. The positive ideal solution is the sum of all the best values that can be achieved for each attribute, while the negative ideal solution consists of all the worst values that can be achieved for each attribute (Rahim et al., 2018). D+ and D- calculations can be seen in Equations (8) and (9).
$$Di^+ = \sqrt{\sum_{j=1}^{n} (yi^+ - y_{ij})^2} \quad (8)$$

 Operations Excellence: Journal of Applied Industrial Engineering, 2024, 16(1): 1-13

$$Di^{-} = \sqrt{\sum_{j=1}^{n}(y_{ij} - yi^{-})^2} \quad (9)$$

6. Determination of the preferred alternative preference value that has the highest preference value. The calculation of the preference value uses Equation (10).

$$V_i = \frac{Di^{-}}{Di^{-}+Di^{+}} \quad (10)$$

In the AHP method, experts evaluate the importance of each criteria to produce a pairwise comparison matrix. The AHP method is utilized to identify the most impactful criteria and generate a weighted value for each criteria (Sitania, 2022). Based on the results of calculations using the AHP method from decomposition, comparative judgement, synthesis of priorities, and logical consistency (Ats-Tsauri et al, 2022), priority vector values or weights for the 6 criteria are obtained. The value of each of these criteria is used as a weight in the TOPSIS method to determine rankings (Maulana et al., 2022). By comparing the distance to the ideal solution using the TOPSIS method, the preference value for each location alternative can be identified. An overview of the research flow can be seen in Fig. 1.

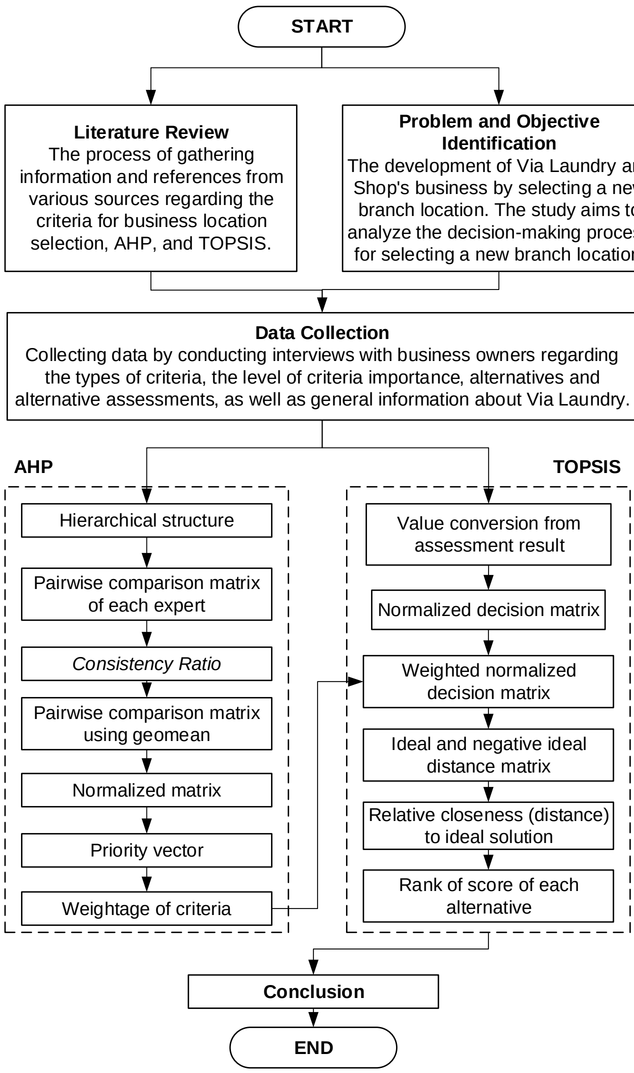

Fig.1 Research flow with AHP – TOPSIS integration.

3. Results and Discussion

Primary data collection was carried out by conducting interviews with two experts, business owner and his partner. The owner has determined three alternative choices for VIA Laundry branch locations, which are Transpark Djuanda Bekasi, Jakarta Garden City, and Harapan Indah. Beforehand, the owners had conducted a survey of other alternative locations, but those with the most adequate specifications were found in three shophouses in the area. Based on research journals related to the criteria for determining business location from previous studies, 10 factors were obtained that were in accordance with the VIA Laundry branch business location, namely population density around the location, location area, rental costs, distance to the nearest market, transportation conditions or ease of access roads (Putri, 2021), water availability (Mondal, T. K. et al, 2018), proximity to competitors, availability of parking space (Önder & Yaşlioğlu, 2016), local salary costs, and location distance from the owner (Khairunnisa & Septiani, 2021).

The importance of criteria such as population density and rental costs is commonly acknowledged in location selection literature (Putri, 2021). For laundry industry, one of the critical decisive factor is water availability and cleanliness (Mondal et al., 2018). These criteria are crucial for customer accessibility and competitive strategy, further validating our decision framework. Of the 10 choices of these criteria, the assessment survey was carried out by giving questionnaires to two experts with experience in the laundry business. Discussions were held with experts regarding the suitability of the criteria and the experts then gave a rating from the most important to the least important. In similar research regarding location selection, there were 4 other criterias that were not taken into consideration in this research for contextual relevancy, specifically: local salary costs, location distance from the owner (Khairunnisa & Septiani, 2021), transportation conditions or ease of access roads (Putri, 2021), and also availability of parking space (Önder & Yaşlioğlu, 2016) as Via Laundry business model is focused more on delivery services. Considering factors such as geographical context, business type, and market conditions, local market dynamics influence criteria weighing differently in various studies. The 6 selected criteria used for decision making can be seen in Table 2.

Table 2 Branch location selection criteria

Code	Criteria	Data Type
K1	Rental cost (million rupiah)	Quantitative
K2	Land area (square meters)	Quantitative
K3	Level of competition	Quantitative
K4	Road accessibility	Qualitative
K5	Water cleanliness	Qualitative
K6	Population density	Qualitative

The predetermined criteria will be weighed up based on the assessment of two experts. In the AHP method, pairwise comparisons are conducted utilizing a functional hierarchy primarily driven by human perception as its core component (Lumenta & Gunawan, 2023). Data processing is carried out according to the stages of the AHP method, as follows:

1. Designing a decision hierarchical structure as shown in Fig. 2.

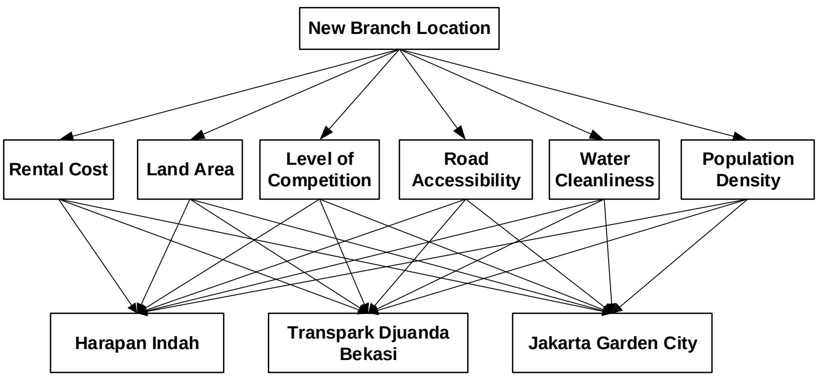

Fig.2 The decision hierarchy structure for determining branch location.

2. The results of the assessment of Expert 1 (owner) and Expert 2 (business partner) for a comparison of each criteria are shown in Table 3.

Table 3 Expert 1 and expert 2 assessment result

Expert	Criteria	K1	K2	K3	K4	K5	K6
Expert 1	K1	1	2	3	0.50	0.50	0.33
	K2	0.50	1	2	3	0.33	0.25
	K3	0.33	0.50	1	0.33	0.33	0.14
	K4	2	0.33	3	1	0.20	0.20
	K5	2	3	2	3	1	0.50
	K6	2	3	7	5	2	1
Expert 2	K1	1	3	2	2	0.50	0.25
	K2	0.33	1	2	2	0.25	0.33
	K3	0.50	0.50	1	0.33	0.33	0.20
	K4	0.50	0.50	3	1	0.25	0.33
	K5	2	4	3	4	1	0.50
	K6	4	3	5	3	2	1

3. Assessment consistency testing is needed to reduce bias in judgments made by experts. The consistency test of expert 1 and expert 2 judgments can be seen in Table 4. CR is obtained by dividing the CI value by the Random Index (RI). The RI value for n = 6 is 1.24. All CR values have met the requirements of no more than 0.1, which means the results are consistent.

Table 4 CI and CR values from expert assessment result

Expert	Consistency Index (CI)	Consistency Ratio (CR)	Conclusion
1	0.0701	0.0565	Consistent
2	0.0837	0.0675	Consistent

4. This study uses the assessment of two experts, so that based on the results of the questionnaire, a combination of the assessments of the two experts uses the geometric mean. The results of the geometric mean are displayed in the pairwise comparison matrix between criteria as shown in Table 5. The combined assessment matrix of the two experts was declared consistent with a Consistency Ratio value of 0.061.

Table 5 Pairwise comparison matrix

	K1	K2	K3	K4	K5	K6
K1	1	2.449	2.449	1	0.5	0.289
K2	0.408	1	2	2.449	0.289	0.289
K3	0.408	0.500	1	0.333	0.333	0.169
K4	1	0.408	3	1	0.224	0.258
K5	2	3.464	3	4.472	1	0.500
K6	3.464	3.464	5.916	3.873	2	1

5. Next, normalized matrix is performed by dividing each value in the pairwise comparison matrix by the number of values per criteria or per column. The result of the normalized matrix between criteria can be seen in Table 6.

Table 6 Normalized matrix

	K1	K2	K3	K4	K5	K6
K1	0.1208	0.2170	0.1411	0.0762	0.1151	0.1153
K2	0.0493	0.0886	0.1152	0.1866	0.0664	0.1153
K3	0.0493	0.0443	0.0576	0.0254	0.0767	0.0675
K4	0.1208	0.0362	0.1728	0.0762	0.0515	0.1031
K5	0.2415	0.3069	0.1728	0.3407	0.2301	0.1996
K6	0.4183	0.3069	0.3407	0.2950	0.4602	0.3993

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6. With the normalized matrix, the weight of each criteria can be determined. Weight determination is calculated by calculating the average of each criteria per row. Based on the calculations, it is known that the criteria with the highest importance weight is population density (K6). This shows that the main consideration in determining the location of the Via Laundry branch is the number of markets around alternative locations, because it will be less than optimal if the location of the branch is not in a densely populated area. The weight results for each criteria can be seen in Table 7.

Table 7 Weightage of criteria

Code	Criteria	Weight	Rank
K6	Population density	0.3701	1
K5	Water cleanliness	0.2486	2
K1	Rental cost (million rupiah)	0.1309	3
K2	Land area (square meters)	0.1036	4
K4	Road accessibility	0.0934	5
K3	Level of competition	0.0535	6

After the assessment is confirmed to be consistent, then an evaluation of 3 alternative locations is carried out with TOPSIS. The weight on each criteria obtained from the AHP calculation will be used as the weight in the calculation using the TOPSIS method. Experts provide an assessment of each alternative based on 6 predetermined criteria. Criteria K1, K2, and K3 are quantitative criteria obtained based on data. Meanwhile, K4, K5, and K6 are qualitative criteria obtained from expert judgment, whom in this case gave the same score. Before proceeding with data processing with TOPSIS, data uniformity was carried out by converting the results of expert assessments to a scale of 1 to 5. Conversion information can be seen in Table 8. Assessment results for each alternative location can be seen in Table 9. Table 10 shows the final value conversion result for each alternative and criteria.

Table 8 Value conversion description

Criteria	Value Conversion	Remarks	Value Range	Criteria	Value Conversion	Remarks
K1	1	very expensive	>35	K4	1	very inaccessible
	2	expensive	30-35		2	inaccessible
	3	moderately cheap	25-30		3	quite accessible
	4	cheap	20-25		4	accessible
	5	very cheap	<20		5	very accessible
K2	1	very small	61-70	K5	1	very dirty
	2	small	71-80		2	dirty
	3	moderately large	81-90		3	quite clean
	4	large	91-100		4	clean
	5	very large	>100		5	very clean
K3	1	very competitive	>5	K6	1	very low density
	2	competitive	4-5		2	low density
	3	quite competitive	2-3		3	dense
	4	uncompetitive	1		4	high density
	5	very uncompetitive	0		5	very high density

Operations Excellence: Journal of Applied Industrial Engineering, 2024, 16(1): 25-35

Table 9 Assessment for each alternative

Code	Criteria	Alternative		
		Transpark Djuanda Bekasi	**Jakarta Garden City**	**Harapan Indah**
K1	Rental Cost (Million Rupiah)	35	27	30
K2	Land area (square meters)	96	90	80
K3	Level of competition	1	4	2
K4	Road accessibility	accessible	accessible	quite accessible
K5	Water cleanliness	clean	quite clean	clean
K6	Population density	very dense	dense	dense

Table 10 Value conversion result

Alternative \ Criteria	K1	K2	K3	K4	K5	K6
Transpark Djuanda Bekasi	2	4	4	4	4	5
Jakarta Garden City	3	3	2	4	3	4
Harapan Indah	3	2	3	3	4	4

7. The next step is to normalize the matrix. The result of the normalized matrix is shown in Table 11.

Table 11 Normalized matrix

Alternative	K1	K2	K3	K4	K5	K6
Transpark Djuanda Bekasi	0.4264	0.7428	0.7428	0.6247	0.6247	0.6623
Jakarta Garden City	0.6396	0.5571	0.3714	0.6247	0.4685	0.5298
Harapan Indah	0.6396	0.3714	0.5571	0.4685	0.6247	0.5298

8. Each value in the matrix is multiplied by the weight of the criteria calculated by the previous AHP method. The normalized and weighted matrix can be seen in Table 12. In TOPSIS there are two types of aspects, one of which describes each criteria, namely aspects of costs and benefits. The cost aspect tends to be for criteria with a negative trend, such as rental costs (K1) and level of competition (K3), and vice versa. Aspects of profit for criteria with a positive trend, such as land area (K2), ease of road access (K4), water cleanliness (K5), and population density (K6).

Table 12 Normalized and weighted matrix

Alternative \ Criteria	K1	K2	K3	K4	K5	K6
	Cost	*Advantage*	*Cost*	*Advantage*	*Advantage*	*Advantage*
Transpark Djuanda Bekasi	0,0558	0,0769	0,0397	0,0583	0,1553	0,2451
Jakarta Garden City	0,0837	0,0577	0,0199	0,0583	0,1165	0,1961
Harapan Indah	0,0837	0,0385	0,0298	0,0438	0,1553	0,1961

9. Based on the matrix above, the calculation is continued by determining the positive ideal solution (A+) and negative ideal solution (A-). For the cost criteria, A+ is obtained by selecting the criteria with the minimum value on the matrix, while A- is obtained by selecting the criteria with the maximum value on the matrix. For profit criteria, A+ is obtained by selecting the criteria with the maximum value in the matrix, while A- is obtained by selecting the criteria with the minimum value in the matrix. The ideal solution for each criteria can be seen in Table 13.

Table 13 Positive and negative ideal solutions

Alternative \ Criteria	K1	K2	K3	K4	K5	K6
A+	0,0558	0,0769	0,0199	0,0583	0,1553	0,2451
A-	0,0837	0,0385	0,0397	0,0438	0,1165	0,1961

10. The next step in the TOPSIS method is to determine the distance of each alternative to the ideal solution, both positive (D+) and negative (D-) ideal solutions. The calculation results shown in Table 14 illustrate the closeness of each alternative to the ideal solution. The positive ideal solution is the sum of all the best values that can be achieved for each attribute, while the negative ideal solution consists of all the worst values that can be achieved for each attribute.

Table 14 Distance to ideal solution

Alternative	D+	D-
Transpark Djuanda Bekasi	0.0199	0.0799
Jakarta Garden City	0.0711	0.0313
Harapan Indah	0.0705	0.0401

11. The last step in TOPSIS is to determine the preference value of each alternative, which can be seen in table 15. This value is obtained by dividing the D- value by the sum of the D+ and D- values for each alternative. The alternative with the greatest preference value is the chosen alternative.

Table 15 Alternative preference values

Alternative	Preference Value	Rank
Transpark Djuanda Bekasi	0.8009	1
Jakarta Garden City	0.3053	2
Harapan Indah	0.3624	3

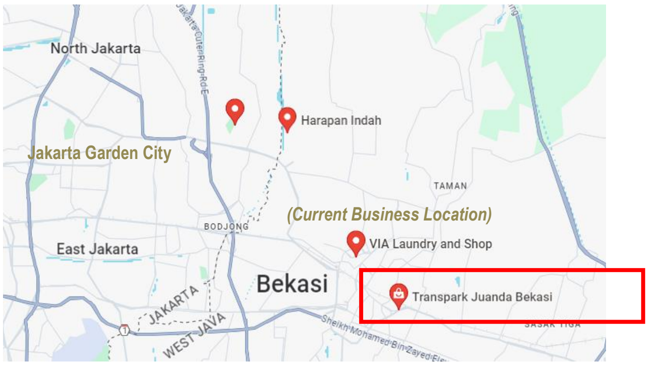

Fig. 3 Map area of alternative locations

Based on the preference value of each alternative equivalent to Table 16, the chosen alternative for the location of the Via Laundry branch is Transpark Djuanda Bekasi with the highest preference value, namely 0.8009. Figure 3 displays the map area of 3 locations. The most important criteria is population density and amongst those 3, Transpark Djuanda Bekasi area has the highest population which influence potential market reach (Putri, S. R., 2021). Transpark Djuanda Bekasi is the best choice even though it has the highest rental price. This is because after calculating the weight of the criteria and comparing it with other alternatives, Transpark Djuanda Bekasi obtains a superior value and produces the distance with the smallest positive ideal solution or closest to the positive ideal solution.

4. Conclusion

The use of a multi-criteria decision-making technique, namely the integration of the AHP and TOPSIS methods, can be used as a tool for choosing a business location for a Via Laundry branch. In determining the location decision for the branch, six criterias were taken into consideration in order of highest weight respectively: population density (0.370), water cleanliness (0.249), rental costs (0.131), land area (0.103), ease of road access (0.093), and the level of competition (0.054). Therefore, population density is the most influential factor in the location selection decision to be determined. Based on the evaluation results of the final calculation with TOPSIS, it is known that Transpark Djuanda Bekasi is the chosen location with the highest preference value of 0.8009. Compared to Jakarta Garden City (0.3053) and Harapan Indah (0.3624), Transpark Djuanda Bekasi obtains the highest score and generates the smallest positive distance to the ideal positive solution, making it the recommendation for the new branch location of Via Laundry.

Future research could expand on this study by incorporating a broader range of decision criteria, such as local labor market conditions, environmental impacts, and customer demographics, to provide a more comprehensive analysis. Additionally, to validate and enhance the robustness of the findings, it would be beneficial to compare the results obtained from AHP and TOPSIS with other multi-criteria decision-making (MCDM) methods, such as ELECTRE, PROMETHEE, or VIKOR, applying these methodologies to the same dataset to examine how different approaches might influence the final decision on the optimal location. These suggestions aim to broaden the scope of research in multi-criteria decision-making and enhance its practical implementation in business strategy development.

References

Akincilar, A. & Dagdeviren, M. (2014). *A Hybrid Multi-Criteria Decision Making Model to Evaluate Hotel Websites. International Journal of Hospitality Management*, *36*(1), 263-271.

Ats-Tsauri, M. I., Iskandar, I., Siregar, B. R. (2022). *Strategi Penentuan Supplier untuk Mitigasi Dampak Kenaikan Harga Bahan Baku pada Industri Manufaktur Baja Lapis Seng. Operations Excellence: Journal of Applied Industrial Engineering, 14*(1), 1-11.

Azwir, H. H., Hasan, F., & Oemar, H. (2020). *Supplier Selection of upper Arm and Lower Arm Pantograph Jack Using AHP and TOPSIS Methods*. *Jurnal Rekayasa Sistem Industri*, *9*(1), 1-10.

Druak, I., Arslan, H. M., Ozdemir, Y. (2021). *Application of AHP-TOPSIS Methods in Technopark Selection of Technology Companies: Turkish Case*, *Technology Analysis & Strategic Management*, *34*(10), 1109-1123.

Fuskova, M., Hanáčková, D., & Gubáňová, M. (2018). *Location Factors and Their Importance in Location Decision Making of Enterprises (In Conditions of Slovak Republic Case Study), Ekonomika Management Inovace (EMI)*, *10*(1), 5-18.

Hakim, S. N., Putra, A. N. (2022). *The Best Location Selection Using Analytical Hierarchy Process Method, International Journal of Industrial Optimization (IJIO)*, *3*(1), 68-79.

Hanggita, A. T. (2018). *Analisis Faktor Pemilihan Lokasi Usaha Jasa pada UMKM di Kecamatan Panciran*. *Jurnal Manajemen Bisnis, 8*(1), 167-176.

Hanin, N., *et al* (2023). *Implementation of AHP-TOPSIS as a Support for Making Decisions on Micro Business Funding in Sambas Regency, International Journal of Economics, Business, and Accounrint Research (IJEBAR)*, *7*(1), 394-410.

Jatiningrum, W. S., *et al* (2022). *Applying AHP-TOPSIS Approach for Selecting Marketplace based on Preferences of Generation Z in Yogyakarta, Indonesia, OPSI*, *15*(1), 107-115.

Khairunnisa, M. & Septiani, W. (2021). *Pemilihan Lokasi Usaha DANI'S Auto Menggunakan Metode Pairwise Comparison dan Comparative Preference Index (CPI)*. *Jurnal Penelitian dan Karya Ilmiah Lembaga Penelitian Universitas Trisakti*, *6*(1), 107-119.

Konstantinos, I., Georgios, T., & Garyfalos, A. (2019). *A Decision Support System methodology for selecting wind farm installation locations using AHP and TOPSIS: Case study in Eastern Macedonia and Thrace region, Greece*. Energy Policy, *132*(1), 232-246.

Lumenta, K. N., Gunawan, W. S. (2023). *Analysis of 220 ml Cup Supplier Selection with AHP Method and Rating Scale: Case Sudy PT. Sabina Tirta Utama, Operations Excellence: Journal of Applied Industrial Engineering*, *15*(2), 164-174.

Maulana, S., Pasaribu, A. M., Septiani, W. (2022). *Pemilihan Pemasok Baterai Forklift Elektrik dengan menggunakan Metode AHP dan TOPSIS di Industri Manufaktur Otomotif. Operations Excellence: Journal of Applied Industrial Engineering*, *14*(3), 261 – 270.

Mondal, T. K., Hussain, U., Ali, ,. I., Rahman, M. S. (2018). *Facility Location Selection for Plastic Manufacturing Industry in Bangladesh by Using AHP Method. International Journal of Research in Industrial Engineering*, *7*(3), 307-319.

Muhammad, J., *et al* (2020). *Pemilihan Supplier Biji Plastik dengan Metode Analytical Hierarchy Process (AHP) dan Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). Jurnal INTECH Teknik Industri Universitas Serang Raya*, *6*(2), 99-106.

Önder, E. & Yaşlioğlu, M. M. (2016). *Solving Facility Location Problem for a Plastic Good Manufacturing Company in Turkey Using AHP and TOPSIS Methods*, *Journal of Administrative Sciences*, *14*(28), 223-249.

Putri, S. R. (2021). *Perbandingan Metode AHP dengan TOPSIS untuk Pemilihan Lokasi Gudang (Studi Kasus Gudang Sepatu Kulit)*. *Scientia Sacra: Jurnal Sains, Teknologi dan Masyarakat*, *1*(1), 13-18.

Rahim, R. *et al* (2018). *TOPSIS Method Application for Decision Support System in Internal Control for Selecting Best Employees. Journal of Physics: Conference Series* 1208 012052.

Saaty, T. L. (1980). *The Analytic Hierarchy Process.* McGraw-Hill, New York.

Septiani, W. & Triwulandari, S.D. (2022). *Analisis Keputusan: Teori dan Implementasi*. Nas Media Pustaka.

Septiani, W. *et al* (2022). *Pelatihan Pengambilan Keputusan pada Industri Komponen Otomotif di Jakarta Utara. Jurnal Abdi Masyarakat Indonesia (JAMIN)*, *2*(2), 145-154.

Singh, M., Singh., K, & Sethi, A. S. (2020). *Analytical Hierarchy Process and TOPSIS for Selecting Best Parameter of Green Manufacturing. Measuring Business Excellence*, *24*(23), 345-365.

Sitania, F. D. (2022). *Supplier Selection Using AHP and TOPSIS: A Case Study in the Bakery. International Conference for Tropical Studies and Its Applications (ICTROPS)*, *1*(1), 1-10.

Sugiyanto, A. Y., Dewi, L. S.,& Arradya, M. A. (2023). *Selection of the Best Location for Opening a Branch Office: a Case Study of Bank X. Operations Excellence: Journal of Applied Industrial Engineering*, *15*(1), 99-109.

Taherdoost, H. (2017). *Decision Making Using the Analytic Hierarchy Process (AHP); A Step by Step Approach. International Journal of Economics and Management Systems*, *2*(1), 244-246.

Tzeng, G. H. & Huang, J. J. (2011). *Multiple Attribute Decision Making: Methods & Applications*. CRC Press.