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Applying the Analytical Hierarchy Process to Select Strategic Locations for Culinary MSMEs in Tomohon City

Penerapan Metode Analytical Hierarchy Process (AHP) dalam Menentukan Lokasi Strategis bagi UMKM Kuliner di Kota Tomohon

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Abstract – Micro, Small, and Medium Enterprises (MSMEs) play a crucial role in Indonesia's economy, making up over 99% of business units. In Tomohon City, located in North Sulawesi, Indonesia; MSMEs, especially in the culinary sector, have faced challenges due to the COVID-19 pandemic, which led to significant revenue losses and business closures. However, recovery efforts are underway, prompting the development of a web-based system to aid culinary businesses in selecting optimal locations. Utilizing the Analytic Hierarchy Process (AHP) method, the system evaluates potential sites based on five criteria: completeness of infrastructure, population density, competition, community incomes, and business capital. Each criterion is assessed using sub-criteria such as very good to very inadequate, providing tailored recommendations for downtown district, Dotu Tololui Tua Statue, Kakaskasen Highway Area, and Beriman Terminal. Among these criteria, infrastructure completeness (40.4%) is prioritized the most, followed by population density (26.2%), competition (18.1%), community incomes (10.4%), and business capital (4.9%). The sensitivity analysis indicates that changes in criteria weights significantly impact the rankings of alternatives, with infrastructure and community incomes causing minor changes but preserving the top-ranked options, while population density and business capital lead to more substantial shifts, including changes in the top position.
Keywords: MSMEs, strategic locations, culinary, Indonesia, AHP

Abstrak – Usaha *Mikro, Kecil, dan Menengah (UMKM) memainkan peran penting dalam perekonomian Indonesia, dengan jumlah lebih dari 99%-unit usaha. Di Kota Tomohon, yang terletak di Sulawesi Utara, Indonesia, UMKM, terutama di sektor kuliner, menghadapi tantangan akibat pandemi COVID-19, yang menyebabkan hilangnya pendapatan yang signifikan dan penutupan bisnis. Namun, upaya pemulihan sedang berlangsung, mendorong pengembangan sistem berbasis web untuk membantu bisnis kuliner dalam memilih lokasi yang optimal. Dengan menggunakan metode Analytic Hierarchy Process (AHP), sistem ini mengevaluasi lokasi potensial berdasarkan lima kriteria: kelengkapan infrastruktur, kepadatan penduduk, persaingan, pendapatan masyarakat, dan modal usaha. Setiap kriteria dinilai dengan menggunakan sub-kriteria seperti sangat baik hingga sangat tidak memadai, memberikan rekomendasi yang disesuaikan untuk distrik pusat kota, Patung Dotu Tololui Tua, Area Jalan Raya Kakaskasen, dan Terminal Beriman. Di antara kriteria-kriteria tersebut, kelengkapan infrastruktur (40,4%) menjadi prioritas utama, diikuti oleh kepadatan penduduk (26,2%), persaingan (18,1%), pendapatan masyarakat (10,4%), dan modal usaha (4,9%). Analisis sensitivitas menunjukkan bahwa perubahan bobot kriteria secara signifikan berdampak pada peringkat alternatif, dengan infrastruktur dan pendapatan masyarakat menyebabkan perubahan kecil tetapi mempertahankan opsi peringkat teratas, sementara kepadatan penduduk dan modal usaha menyebabkan pergeseran yang lebih besar, termasuk perubahan pada posisi teratas.*
Kata kunci: UMKM, lokasi ktrategis, Kuliner, Indonesia, AHP

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INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) are economic activities operated by individuals or groups with a net income of up to 200 million (Adhiarta & Sabrina, 2021; Nasution & Ichsan, 2021; Vinatra, 2023; KADIN Indonesia, 2023). The government has regulated the management of MSMEs in Law No. 20/2008 on Micro, Small, and Medium Enterprises. BPS (Central Bureau of Statistics) classifies the type of business unit in terms of the number of workers used, namely small businesses have a workforce of 5-19 people, and medium-sized businesses have a workforce of 20-99 people (Vinatra, 2023). MSMEs are the backbone of the economy in many countries like Indonesia (Kementerian Perdagangan RI, 2024; KADIN Indonesia, 2023; Rojas-Lema, Pumisacho, Alfaro-Saiz, & Garcia, 2019). Kementerian Perdagangan RI and KADIN Indonesia also added that over 99 percent of business units in Indonesia are micro-enterprises. In 2023, approximately 66 million MSMEs are operating in the country.

Tomohon City, known as the "City of Flowers" in North Sulawesi, has a population density of 679.81 persons/km² in 2023 and is a popular tourist destination with a growing culinary scene (BPS Kota Tomohon, 2024). In 2022, 53% of household expenditure was spent on food from MSMEs, indicating the thriving culinary tourism with 131 MSMEs. However, the number of culinary MSMEs decreased from 213 in 2021 due to the impact of COVID-19 (BPS Kota Tomohon, 2023).

COVID-19 has significantly affected the national economy (Hidayat, 2023; Sasongko, 2020), and culinary MSMEs in Tomohon City have experienced similar impacts. Some of the impacts include a reduction in revenue of up to 50% for culinary businesses in Tomohon, caused by social restrictions and a decline in visitor numbers. Many restaurants and food stalls have been forced to close temporarily or permanently due to the inability to survive. The Ministry of Cooperatives and SMEs reported that 60% of MSMEs in the culinary sector have been negatively impacted, with many forced to reduce capacity or close (Fachrizah, et al., 2020). Data from the Tomohon City Office of Cooperatives and MSMEs also showed that around 40% of culinary businesses in Tomohon experienced severe financial difficulties during the pandemic (Pemerintah Kota Tomohon, 2022).

Post-COVID-19 pandemic, Tomohon's culinary MSMEs have shown signs of recovery, though the revenues have not yet reached pre-pandemic levels. Government support programs, including subsidies, training, and marketing assistance, have helped, but the pandemic underscored the need for better decision-making tools, especially for selecting business locations. While initiatives like the PEN program and the Job Creation Law aid recovery, technology-driven solutions for data-based decision-making are still needed (Pemerintah Kota Tomohon, 2022; Hidayat, 2023).

In the post-pandemic recovery phase, entrepreneurs in Tomohon must navigate intense competition and shifting market dynamics. To gather critical location data, many still rely on inefficient, manual methods such as personal site visits or consultations with local authorities (Turalaki, 2024). The decision-making process involves several factors such as infrastructure (Husen & Baranyanan, 2021), population density (Marpaung & Siahaan), competition (Bakar & Hasan, 2024; Kumar, Rangaiah, & Kumar, 2023), community incomes (Nasution & Ichsan, 2021), and available business capital (Rompas, 2024; Hidayat, 2023; Lasoma, Sofhian, & Zainuddin, 2021). Key areas for culinary MSMEs in Tomohon, such as the downtown district, Dotu Tololui Tua Statue, Kakaskasen Highway Area, and Beriman Terminal, have been designated by the local government as hubs for business activity, with MSME booths set up in these locations. However, the absence of a computerized system to recommend strategic locations based on specific business criteria remains a significant challenge.

This research creates a web-based system that can recommend strategic locations for culinary businesses in Tomohon City, utilizing the AHP method to align with specific preferences. AHP is widely used to explain equal preferences among criteria, sub-criteria, and alternatives using a pairwise comparison matrix (Gaspars-Wieloch, 2024; Raco, et al., 2021). AHP remains superior since this method adopts a hierarchical approach that breaks down complex problems into simpler components (Kunang & Seprina, 2020).

This research is relevant to informatics and communication as it develops a web-based support system using the AHP method to recommend business locations. The system enhances digital information

delivery through an intuitive and communicative interface, enabling MSME entrepreneurs to access and apply data-driven insights effectively.

AHP has been used in many studies (Gaspars-Wieloch, 2024; Raco, et al., 2021; Rinova & Imanuel, 2021; Kunang & Seprina, 2020; Ramadhan & Saf, 2020; Prasetyaningrum & Sari, 2019). Kunang and Seprina's research applied AHP to select business locations for MSMEs in Alang-Alang Lebar, Palembang, using nine criteria but did not specify the types of MSMEs targeted. These criteria included rental fees, renovation needs, availability of clean water and electricity, and proximity to suppliers (Kunang & Seprina, 2020). Another study focused on four criteria to recommend shophouse locations in Pekanbaru City (Ramadhan & Saf, 2020). A third study determined business locations for Eternal Treatment Services Lab using four criteria: facilities, rental fees, market environment, and physical condition of the location. The study evaluated four alternative locations in Bandar Lampung: Wayhalim, Labuhan Ratu, Teluk Beting, and Rajabasa (Rinova & Imanuel, 2021). While existing studies have focused on technical methods like the Analytic Hierarchy Process (AHP) for business location selection (Rinova & Imanuel, 2021; Kunang & Seprina, 2020; Ramadhan & Saf, 2020), these approaches have largely neglected the interaction between technology and human factors. For MSMEs to thrive in a competitive environment, integrating decision-support systems must account for socio-technical aspects, including how entrepreneurs interact with technology and how such systems influence their decision-making processes.

What sets this study apart from previous research is its emphasis on identifying optimal locations for culinary businesses in Tomohon City. This study adjusted the weighted based on more contextual factors to demonstrate the flexibility of AHP for different business sectors. In this regard, this study evaluates potential location using five criteria—completeness of infrastructure, population density, competitors, community incomes, and business capital—and assesses them based on five sub-criteria: very good, good, adequate, inadequate, and very inadequate. The alternative locations are the downtown district, the Dotu Tololui Tua Statue, the Kakaskasen Highway Area, and the Beriman Terminal.

This system provides data-driven recommendations to help MSME entrepreneurs in Tomohon City select optimal locations for their culinary businesses, improving competitiveness and market access. By ensuring visibility and accessibility, a strategic location can boost market reach, reduce costs, and lower business risks. This paper is structured as follows: 1) introduction, 2) research method, 3) results and discussion, and 4) conclusions and future work.

RESEARCH METHOD

This research uses the AHP method that involves several stages in producing a decision as follows (Ramadhan & Saf, 2020):

Research Sample

There are two sources of data collection, namely:

1. Primary data was obtained through interviews with prospective culinary business entrepreneurs and the Head of the Empowerment and Development Division of the Cooperative Office and MSMEs of Tomohon City to gather data related to criteria and alternatives.
2. Secondary data is a collection of data obtained through books, scientific journals, or e-books that are related to the theory of making this research. All information obtained from primary data will be used as a reference in setting criteria, and alternatives. Furthermore, secondary data will be used as a guide to develop the system through modeling using UML, flowchart, and ERD. It also serves as a support in database creation.

Steps in the AHP Method

1. Determining the Hierarchical Structure or Decomposition
   This stage identifies the problem and establishes the desired solution. Problem identification is poured in the form of criteria, and alternatives so that a hierarchical structure can be arranged. The highest level represents the research goal, the second level denotes the criteria, the second level shows sub-criteria, and the third level consists of the alternatives, as illustrated in Figure 1.

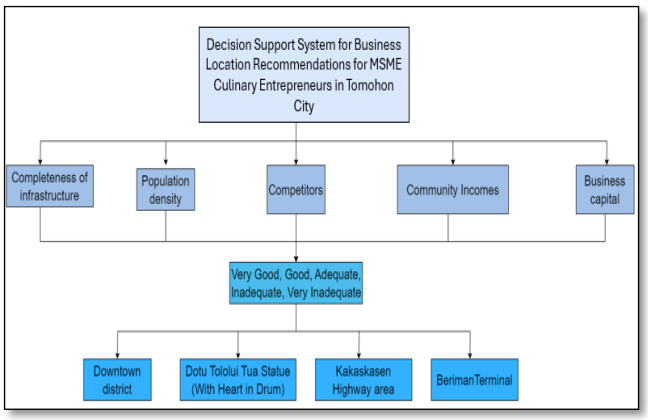

Figure 1 Hierarchical framework of AHP

2. Providing Assessment

   The assessment is carried out with the following steps: a) Comparing components in pairs according to predetermined criteria. b) Fill in the pairwise comparison matrix with importance values that reflect the level of importance of one criterion and sub-criteria with others.

   The importance value can be seen in Table 1 below.

Table 1 Importance Score (Raco, et al., 2021; Ramadhan & Saf, 2020)

IIoAS	R	ToI	Definition
1	1	Equal Importance.	Both alternatives have the same level of equality.
3	1/3	Moderate significance of one in comparison to another.	Have a slightly higher level of importance than the other.
5	1/5	Significant or strong importance.	Have a fairly significant level of importance compared to the others.
7	1/7	Very strong importance.	Have a very high level of importance.
9	1/9	Extreme importance.	Very significant.
2, 4, 6, & 8	1/2, 1/4, 1/6, & 1/8	Intermediate values between the two neighboring assessments.	A value that is between two almost equal assessments.

Table Notes:
IIoAS = Intensity of Importance on an Absolute Scale, R = Reciprocal, ToI = Types of Importance.

3. Synthesizing

   In this stage, the evaluations of the pairwise comparisons are combined or synthesized to determine the overall priority.

   a. Sum the total value of each column in the matrix.

   For a set of n elements (criteria, sub-criteria, or alternatives), the pairwise comparison matrix A is an $n \times n$ matrix where:

   - Each element aij represents the relative importance of element i compared to element j.
   - The diagonal elements aii are all 1 because an element compared to itself has equal importance.
   - The matrix is reciprocal, meaning $aij = \frac{1}{a_{ji}}$

$$A = [a_{ij}], \quad a_{ij} = \frac{W_i}{W_j}, \quad a_{ji} = \frac{1}{a_{ij}}, \quad a_{ii} = 1 \qquad (1)$$

   b. Normalize the matrix by dividing each element in a column by the total of that column.

$$b_{ij} = \frac{a_{ij}}{\sum_{i=n}^{n} a_{ij}} \qquad (2)$$

   c. Calculate the average value by summing up all the values from each row, and then divide it by the number of elements present.

$$W_i = \frac{\sum_{i=n}^{n} b_{ij}}{n} \qquad (3)$$

   Note:
   W_i = i-th weight of the priority weight

4. Determining Consistency

   In the decision-making process, assessing the level of consistency plays a very important role, as decisions based on inconsistent considerations are not suitable to support a decision. Some of the steps involved include:

   a. Multiplication of the values in each column with the assigned priority weights, and so on.
   b. The sum of the results in each row will produce the maximum value called λ (lambda) max.

$$\lambda_{max} = \sum_{i=1}^{n} \frac{(Aw)_i}{nw_i} \qquad (4)$$

   Note:
   λ_{max} = eigen value max
   n = the number of criteria, sub-criteria, or alternatives in the matrix

5. Calculating Consistency Index (CI)

   The CI calculation will use the formula below.

$$CI = \frac{(\lambda_{max} - n)}{(n-1)} \qquad (5)$$

   The calculation of the consistency index and ratio indicates that the responses provided by the participants may be inconsistent. This inconsistency arises from the subjective nature of the numerical values given by individuals. While some degrees of

inconsistency is unavoidable, it is generally within acceptable or tolerable limits.

6. Calculating Consistency Ratio (CR)
   The formula to calculate CR is:

$$CR = \frac{CI}{RI} \quad (6)$$

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R.I	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Figure 2 Ratio Index (Raco, et al., 2021)

   This study has 5 criteria and therefore the ratio index to use is 1.12.

7. Measuring Hierarchy Consistency
   Evaluation through an assessment of the consistency ratio (CR). If the consistency ratio value exceeds 0.1, it is important to examine the evaluation data for the criteria, sub-criteria, and alternatives. Conversely, if the consistency ratio <= 0.1, then the calculation results can be recommended.

8. Perform Sensitivity Analysis
   This study conducted a sensitivity analysis to identify which criteria or judgments most significantly influence the decision outcomes. This helps decision-makers focus on the most critical factors and understand where more precise data might be needed. Super Decision v3.2 is used for sensitivity analysis.

Design

This section will present various system designs using UML (Unified Modeling Language) diagrams, including use case, class, and activity diagrams, to demonstrate how users interact with the system.

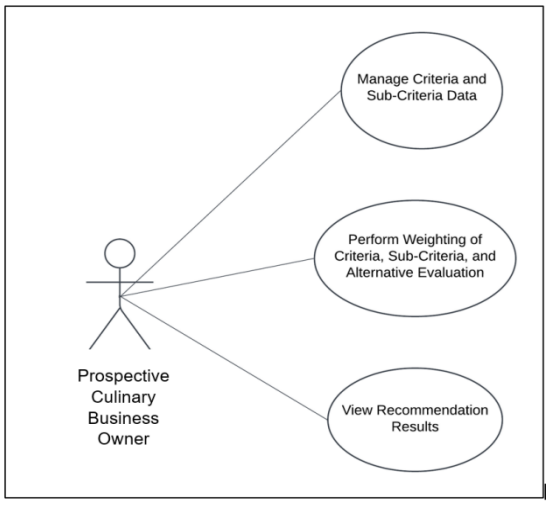

Figure 3 Use Case Diagram

The prospective culinary business owner must input values for the five criteria based on their preferences. This study offers four alternative culinary locations. After the input is completed, the system will process the data following the steps of the AHP method, which includes weighting the criteria, sub-criteria, and alternatives, to calculate priorities and scores based on their preferences. This owner can later view the recommendation results, which display the ranked business locations, aiding in the decision-making process.

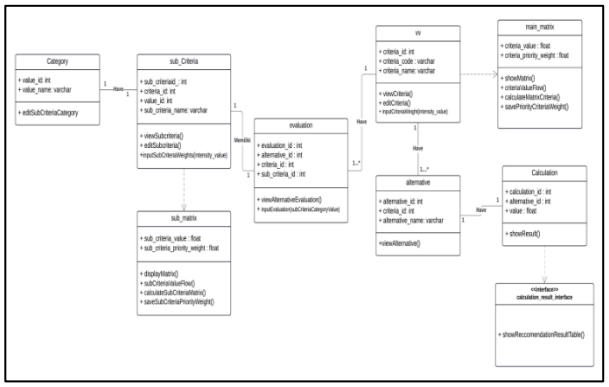

Figure 4 Class Diagram

The class diagram in Figure 4 provides a clear structural overview of the DSS, ensuring smooth development and effective communication between stakeholders. It captures the essence of how the system handles data, processes decisions, and delivers recommendations.

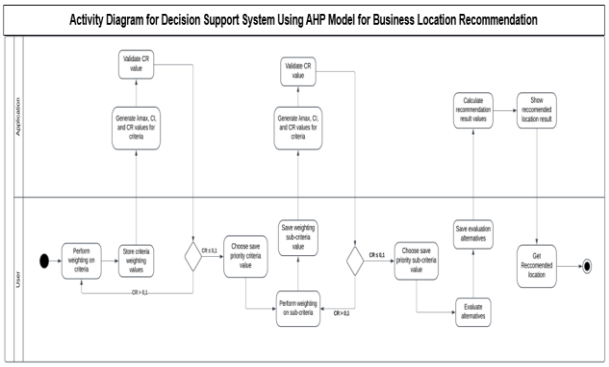

Figure 5 Activity Diagram

Figure 5 demonstrates the AHP model for culinary business location recommendation. The user begins by assigning weights to the criteria and sub-criteria, and the system validates the Consistency Ratio (CR) to ensure it is within the acceptable limit (≤ 0.1). Once the CR is validated, the system saves the priority values for both criteria and sub-criteria and proceeds to evaluate alternatives. After calculating and saving the scores for alternatives, the system generates and

displays the recommended business locations based on the AHP method.

RESULTS AND DISCUSSION

This study aims to help MSME entrepreneurs identify the right culinary business locations in Tomohon City based on their preferences to provide a competitive advantage over rivals by securing a favorable market position. This study evaluates potential locations using five criteria, namely completeness of infrastructure, population density, competitors, community incomes, and business capital. Next, this study evaluates them using five sub-criteria, namely very good, good, adequate, inadequate, and very inadequate. As for the alternatives, the locations are the downtown district, the Dotu Tololui Tua Statue, the Kakaskasen Highway Area, and the Beriman Terminal. The values for each sub-criteria under the criteria are presented in Table 2 through Table 6.

Table 2 Sub-Criteria of Infrastructure Criteria

Code	Sub-criteria	Definition
SC1	1. Parking Lot. 2. Clean Water Availability. 3. Paved Road Condition. 4. Electricity Current 5. Telecommunication Service is Smooth. 6. Public Transportation is available around the location. 7. Environmentally Friendly. 8. 8. Supporting facilities: Bank/ATM within easy reach.	Very good
SC2	Only fulfill 6 or 7 sub-criteria.	Good
SC3	Only fulfill 4 or 5 sub-criteria.	Adequate
SC4	Only fulfill 2 or 3 sub-criteria.	Inadequate
SC5	Meet only 1 or none of the sub-criteria.	Very inadequate

Table 3 Sub-Criteria of Population Density Criteria

Code	Sub-criteria	Definition
SC1	≥ 4160	Very good
SC2	3320 - 4159	Good
SC3	2480 – 3319	Adequate
SC4	1640 - 2479	Inadequate
SC5	≤ 1639	Very Inadequate

Table 4 Sub-Criteria of Competitors

Code	Sub-criteria	Definition
SC1	0-1	Very Good
SC2	2- 3	Good
SC3	4-5	Adequate
SC4	6 -7	Inadequate
SC5	≥ 8	Very Inadequate

Table 5 Sub-Criteria of Community Incomes

Code	Sub-criteria	Definition
SC1	> 4.000.000	Very Good
SC2	2.800.000 – 3.400.000	Good
SC3	2.200.000 – 2.800.000	Adequate
SC4	1.600.000 - 2.200.000	Inadequate
SC5	< 1.600.000	Very Inadequate

Table 6 Sub-Criteria of Business Capital

Code	Sub-criteria	Definition
SC1	12-15 billion	Very good
SC2	9-12 billion	Good
SC3	6-9 billion	Adequate
SC4	3-6 billion	Inadequate
SC5	< 3 billion	Very inadequate

The data analysis showed that the criteria, sub-criteria, and alternatives were consistent, with a consistency ratio (CR) under 0.1, validating the results. Data processing and analysis were conducted using Microsoft Excel 2019. For prospective culinary entrepreneurs in Tomohon City, the Tomohon City Cooperatives and MSMEs Office offers a web-based system that provides personalized location recommendations based on individual preferences, allowing users to input their weights for the criteria and alternatives.

The following data displays the information an entrepreneur gives into the web-based application, which processes input from one user at a time. There are 5 criteria used in this study. The priority weight, calculated using Equation 3, is shown in Table 7 and Table 8.

Table 7 Pairwise Comparison of The Criteria

Criteria	C1	C2	C3	C4	C5
C1	1	3	3	3	5
C2	0,333	1	3	3	5

C3	0,333	0,333	1	3	5
C4	0,333	0,333	0,333	1	3
C5	0,2	0,2	0,2	0,333	1
Total	**2,2**	**4,867**	**7,533**	**10,333**	**19**

Table 8 Pairwise Comparison, ʎ-Max, Priority, CI, And CR of The Criteria

C	C1	C2	C3	C4	C5	Total	P
C1	0.46	0.62	0.39	0.29	0.26	**2,023**	**0.405**
C2	0.15	0.21	0.39	0.29	0.26	**1,309**	**0.262**
C3	0.15	0.07	0.13	0.29	0.26	**0,906**	**0.181**
C4	0.15	0.07	0.04	0.09	0.16	**0,519**	**0.104**
C5	0.09	0.04	0.03	0.03	0.05	**0,243**	**0.049**
λ maks = 5.395		**CI = 0.098**			**CR = 0.088 (CR < 0.1)**		

Table Notes:
C = Criteria, P = Priorities,
C1 = Completeness of Infrastructure
C2 = Population Density, C3 = Competitors
C4 = Community Incomes, C5 = Business Capital

The ratio is considered consistent since CR is less than or equal to 0.1. If the consistency is confirmed, the AHP method calculation is acceptable and complete.

The next step is to perform a pairwise comparison for the sub-criteria as shown in Table 9.

Table 9 Pairwise Comparison of The Sub-Criteria

Sub-criteria	SC1	SC2	SC3	SC4	SC5
SC1	1	3	5	3	7
SC2	0,3	1	3	3	5
SC3	0,2	0,333	1	3	3
SC4	0,33	0,333	0,333	1	3
SC5	0,1429	0,2	0,333	0,333	1
Total	**2,0**	**4,867**	**9,667**	**10,3**	**19**

Using the values of the pairwise comparison above, it can later calculate the priorities, ʎ-Max, CI, And CR of the sub-criteria as illustrated in Table 10. The priority column (*) is calculated by dividing the number by the total sub-criteria. For instance, the priority of SC1= total SC1/5 criteria= 2,290/5 = 0.458. Among all the values in the priority column, the highest is 0.458. The sub-criteria priority column is determined using the formula: priority value / maximum priority value. These values from the sub-criteria priority column will be used as the weight for each sub-criteria.

Table 10 Priority, ʎ-Max, CI, And CR of The Sub-Criteria.

Sub-criteria	SC1	SC2	SC3	SC4	SC5	Total	Priorities*	Priorities of sub-criteria**
SC1	0.472	0.610	0.391	0.353	0.313	2,290	**0.458**	**1**
SC2	0.157	0.203	0.391	0.265	0.25	1,235	**0.247**	**0,539**
SC3	0.157	0.068	0.130	0.265	0.188	0,7197	**0.144**	**0,314**
SC4	0.118	0.068	0.043	0.088	0.188	0,524	**0.105**	**0,227**
SC5	0.094	0.051	0.043	0.029	0.06	0,233	**0.046**	**0,101**
λ maks = 5,33974		**CI = 0,08494**			**CR = 0,075836 (CR < 0,1)**			

Note:
SC1 = Very Good, SC2 = Good
SC3 = Adequate, SC4 = Inadequate
SC5 = Very Inadequate

* Priority is utilized to determine the values for the different alternatives.
**The priority of sub-criteria is employed to compute λ_max, CI, and CR.

Table 11 Pairwise Comparison, Priority, ʎ-Max, CI, And CR of The Alternatives

Location	C1	C2	C3	C4	C5
Downtown District	Adequate	Adequate	Good	Inadequate	Very Inadequate
The Dotu Tololui Tua Statue	Inadequate	Good	Inadequate	Very Inadequate	Very Inadequate
The Kakaskasen	Very Inadequate	Inadequate	Very Inadequate	Inadequate	Inadequate
Beriman Terminal	Adequate	Very Inadequate	Very Inadequate	Very Inadequate	Inadequate

Table 12 The Final Results for The Alternatives

Location	Completeness of Infrastructure	Population Density	Competitors	Community Incomes	Business Capital	Total
Downtown District	0.12713	0.08226	0.09776	0.02373	0.00492	0.33580
The Dotu Tololui Tua Statue	0.09248	0.14117	0.04143	0.01049	0.00492	0.29051
The Kakaskasen Highway Area	0.04090	0.05984	0.01833	0.02373	0.01113	0.15392
Beriman Terminal	0.12713	0.02647	0.01833	0.01049	0.01113	0.19355
						0.97378

The formula multiplies the priority value of the criterion by the weighted priority value of the sub-criterion. For instance, the completeness of infrastructure in the Downtown District is adequate. The priority value for the completeness infrastructure is 0,405 in Table 8. The value of the adequate sub-criterion is 0.314 (refer to the Priority of Sub-Criteria in Table 10). Therefore, the result for the Download District is 0.12713 as shown in Table 12. Apply the same process to the alternatives for each criterion. Lastly, the total column is derived by summing the results of each row.

Table 13 AHP Results

Alternative	AHP Result
Downtown District	**0,33580**
The Dotu Tololui Tua Statue	**0,29051**
The Kakaskasen Highway Area	**0,15392**
Beriman Terminal	**0,19355**

Among the five criteria assessed as shown in Table 8, the completeness of infrastructure (40.4%) emerged as the top priority for culinary entrepreneurs. This was followed by population density (26.2%), competitors (18.1%), community incomes (10.4%), and business capital (4.9%). Surprisingly, business capital, though significant, is not the main factor driving the decision to recommend a strategic location for a culinary business in Tomohon City for several reasons. Firstly, infrastructure completed emerged as the most influential factor (45.8%) in selecting business locations in Tomohon, directly impacting operational efficiency and customer accessibility (Hansen & Johansen, 2023; Bénétrix & Lane, 2022). They believe that adequate infrastructure guarantees that key services like utilities, transportation, and communication are available, which can greatly influence the success and sustainability of the business (Akinboade & Kinfack, 2023; Chen & Li, 2021). This finding aligns with Kunang and Sabrina (2020), who employed the AHP method for MSME location in Palembang. However, unlike their study, which did not specify MSME types, our research focuses specifically on culinary businesses in Tomohon City, incorporating five distict criteria tailored to this sector. This specifically enhances the applicability of our decision support system for culinary MSMEs, addressing a grap identified in previous literature.

Secondly, population density (24.7%) is crucial because it influences the size of the potential customer base. Greater population density typically results in more potential customers, which can increase foot traffic and sales for culinary businesses (Brown & Smith, 2024; Li & Zhang, 2023; Fujii & Saito, 2021). Thirdly, the presence and density of competitors (14.4%) affect market dynamics. Analyzing the competitive environment assists in identifying market gaps and positioning the business more strategically (Nguyen & Lee, 2024; Gao & Zhang, 2023; Lee & Choi, 2020). Fourthly, the income levels of the local community (10.5%) impact purchasing power (Amin & Ahmad, 2023). Higher income levels generally result in increased spending on dining out (Nguyen, 2023; Johnson & Walker, 2022; Smith & Gupta, 2021).

Based on the result in Table 13, the recommended strategic locations, ranked from highest to lowest scores, are Downtown District (33.58%), The Dotu Tololui Tua Statue (29.05%), Beriman Terminal (19.34%), and Kakaskasen Highway Area (15.39%). Sensitivity analysis was conducted with the help of superdecision software version 3.2.

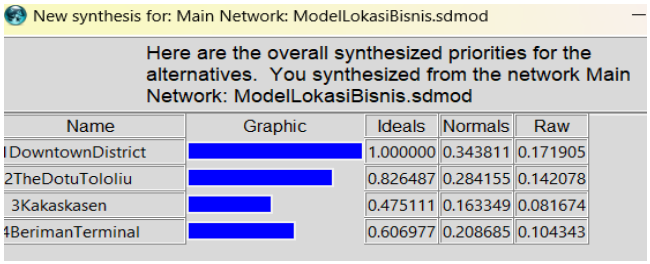

Figure 6 Original Results Obtained from Super Decision

Completeness of Infrastructure Criteria

The analysis of these criteria shows two changes in the ranking of alternatives: When the weight of the infrastructure criteria increases above 27%, the alternative ranking initially in position 4 changes to position 3. When the weight of the infrastructure criteria increases above 69%, the ranking order of the alternatives changes as follows, starting from the highest: location 1 (33.6%), location 4 (26.4%), location 2 (26.3%), and location 3 (13.6%). Nonetheless, the first ranked alternative remains unchanged compared to the initial results, which is location 1.

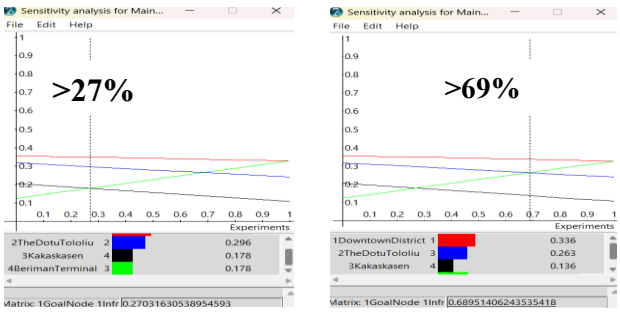

Figure 7 Completeness of Infrastructure Criteria.

Population Density Criteria

This analysis shows three changes in the ranking of alternatives related to the population density criterion; An increase in criterion weight above 8.6% changes the ranking of alternatives from position 3 to position 2. With a weight above 45%, the ranking of alternative 1 drops to position 2. Next, A further increase above 49% changes the ranking order to location 2 (33.6%), location 1 (32.0%), location 3 (17.2%), and location 4 (17.1%).

The results show that the population density criterion is very sensitive to weight changes, even small changes can significantly affect the ranking of alternatives.

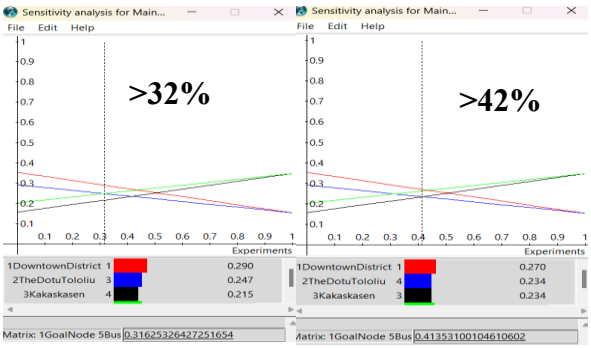

Figure 8 Population Density Criteria.

Community Incomes Criteria

Analysis of this criterion shows two changes in alternative rankings. However, the first alternative ranking remains unchanged from the initial results, namely location 1; When the weight of this criterion increases above 27%, the alternative ranking that was previously in position 4 shifts to position 3. With an increase in weight above 45%, the alternative ranking that was originally in position 3 rose to position 2.

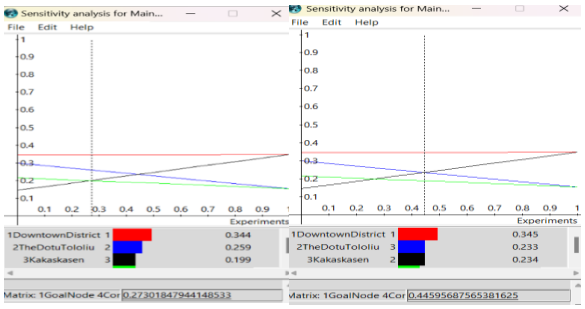

Figure 9 Community Income Criteria

Business Capital Criteria

The analysis of this criterion shows the occurrence of four changes in the ranking of alternatives, which resulted in the first ranking of alternatives changing compared to the initial results; When the weight of this criterion increases above 32%, the alternative ranking that was originally in position 3 shifts to position 2. Furthermore, with an increase in weight above 42%, the alternative ranking that was previously in position 4 rises to position 3.

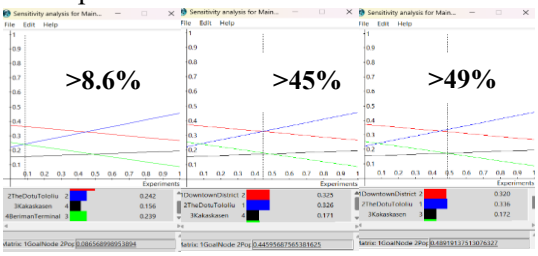

Figure 10 Business Capital Criteria Increased By 32% And 42%

1. As the weight of the criteria increases above 45%, alternative 1 drops to position 2. When the weight exceeds 52%, alternative 3 rises to position 2.
2. The final ranking and weights are: location 4 (27.6%), location 3 (25.3%), location 1 (25%), and location 2 (22%).

These results show that alternative rankings are very sensitive to changes in criteria weights, as seen from four changes in rankings and changes in the position of alternative rank 1 compared to the initial results.

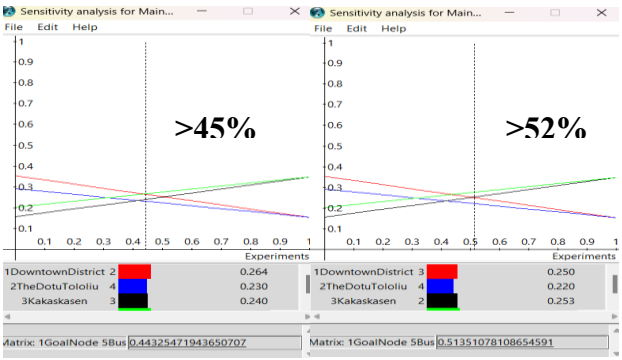

Figure 11 Business capital criteria increased by 45% and 52%

CONCLUSIONS

A web-based system has been developed to assist MSME entrepreneurs in Tomohon City in choosing strategic locations for their culinary businesses. This system offers an innovative, user-centered approach that allows entrepreneurs to explore location options independently by adjusting criteria based on their business needs. Its web-based nature enhances accessibility and usability, enabling broader participation from digitally-inclined MSMEs. In the post-pandemic context, this tool contributes to recovery efforts by equipping culinary entrepreneurs with data-driven insights and supporting their digital transformation amid changing market dynamics. Moreover, it reduces reliance on intuition and advances digital transformation in the culinary sector through accessible business analytic.

The system evaluates potential sites based on five criteria: infrastructure completeness, population density, competition, community income, and business capital. Among these, infrastructure completeness (40.4%) was identified as the most critical factor, followed by population density, population density (26.2%), competitors (18.1%), community incomes (10.4%), and business capital (4.9%). Interestingly, although business capital is essential for the financial management of a culinary business, factors such as infrastructure, population density, and competition have a more immediate and direct effect on the business's operational success and market viability. The recommended locations, in descending order of preference, are the Downtown District (33.58%), The Dotu Tololui Tua Statue (29.05%), Beriman Terminal (19.34%), and Kakaskasen Highway Area (15.39%).

The analysis reveals that changes in criteria weights lead to significant shifts in the rankings of alternatives. For the infrastructure criteria, ranking changes occurred twice, but the top-ranked alternative remained consistent as location 1. The population density criterion showed high sensitivity to weight changes, resulting in three ranking shifts and a final order where even small adjustments impacted rankings substantially. Similarly, community income criteria also led to two ranking changes, with the top-ranked alternative remaining unchanged. In contrast, the business capital criteria caused four ranking changes, including a shift in the top alternative position, demonstrating a high sensitivity to weight variations.

This study's criteria and alternatives may not cover all factors that influence the success of a culinary business in Tomohon. In line with this, The study's recommendations may not fully consider the impact of broader economic or social changes, such as economic downturns or shifts in consumer behavior. Also, assigning weights to the criteria, sub-criteria, and alternatives can be influenced by personal judgment, which may compromise the objectivity of the recommendations.

For future work, it is essential to expand the criteria and alternatives considered. This includes adding factors like regulatory compliance, seasonal demand fluctuations, and local market trends specific to Tomohon. Integrating these elements into the evaluation model will improve recommendations. Engaging local culinary entrepreneurs, industry experts, business consultants, academic institutions, and regulatory authorities is vital for identifying additional relevant factors. For alternatives, obtaining local economic reports and infrastructure assessments will enhance the evaluation criteria. Conducting case studies or pilot tests with selected locations and gathering feedback can refine the evaluation model.

There is a need to to address the impact of broader economic and social changes, establish key performance indicators (KPIs) and monitoring tools to track relevant economic and social trends. Additionally, to minimize personal bias in weighting criteria and alternatives, form a diverse panel of experts to collaboratively assign weights, improving the reliability of the assessment.

In terms of information technology, this system needs to pay attention to user data security aspects such as input encryption and interoperability with local MSME information systems such as cooperative databases or trade offices. The utilization of an open-web-based system also must support integration to other tools like GIS mapping systems or strategic location monitoring dashboards.

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