THE APPLICATION OF ANALYTICAL HIERARCHY PROCESS (AHP) TO DETERMINE BEST CITY FOR TEA FACTORY OPENING
(A CASE STUDY OF PT. SURYA SENTOSA SEJAHTERA)

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ABSTRAK

PT. Surya Sentosa Sejahtera (PT SSS), produsen teh terkemuka di Indonesia, menghadapi urgensi yang mendesak untuk menggapai konsumen secara nasional dengan biaya yang efektif dalam industri teh yang berkembang pesat. Saluran distribusi saat ini, berasal dari fasilitas yang berlokasi di Medan, Sumatera Utara, menimbulkan biaya pengiriman yang signifikan untuk tujuan di luar pulau Sumatera. Biaya logistik yang tinggi ini, sekitar lima puluh persen lebih tinggi dari yang ideal, berdampak negatif pada margin keuntungan perusahaan dan menghambat ekspansi. Sebagai respons, perusahaan berencana membangun pabrik baru di lokasi yang lebih strategis pada tahun 2025, tetapi lokasi pabrik yang optimal masih belum dapat dipastikan. Dengan tujuan utama meningkatkan efisiensi logistik, penelitian ini berfokus pada penggunaan *Analytical Hierarchy Process* (AHP) sebagai salah satu metode *Multi-Criteria Decision Making* (MCDM) untuk mengidentifikasi lokasi paling sesuai untuk mendirikan pabrik the. Metode AHP lalu dikembangkan melalui tinjauan literatur dan sesi diskusi dengan karyawan kunci yang terlibat dalam proyek ini. Empat kriteria penting yang telah diidentifikasi, yang terdiri dari dua belas sub-kriteria, mengarah pada lima lokasi alternatif. Pada tingkat kriteria, analisis AHP menunjukkan bahwa Kapabilitas Organisasi memiliki bobot tertinggi, diikuti oleh Lokasi, Kebutuhan Operasional, dan Kelayakan Finansial secara berurutan. Pada tingkat sub-kriteria, Kesiapan Kemitraan muncul sebagai yang paling signifikan, diikuti oleh Ketersediaan Pengawas Manufaktur, Area Prospektif, dan Kemudahan Membangun Jaringan Distribusi. Pada tingkat alternatif, Surabaya diidentifikasi sebagai lokasi yang paling diutamakan, diikuti oleh Bogor, Lampung, Batam, dan Makassar.

Kata kunci : Industri Teh; Lokasi Pabrik; Efisiensi Logistik; AHP; MCDM

ABSTRACT

PT Surya Sentosa Sejahtera (PT SSS), a leading tea manufacturer in Indonesia, faces a pressing urgency to reach consumers nationwide in a cost-effective manner within the booming tea industry. The current distribution channel, originating from their facility located in Medan, North Sumatera, incurs substantial delivery costs for destinations outside Sumatra. These high logistic expenses, about fifty percent more than ideal, negatively impact the company's profit margins and hinder expansion. In response, the company intends to construct a new facility in a more strategic location in 2025, but the optimal factory location remains uncertain. With the core objective of enhancing logistic efficiency, the study centers on utilizing the Analytical Hierarchy Process (AHP) as one of the Multi-Criteria Decision Making (MCDM) method to identify the most suitable location for establishing tea plant. The AHP method is developed through a literature review and brainstorming with five key employees who *are involved in the project. Four-critical criteria are identified, consisting a total of twelve sub-criteria, leading to five alternative locations. In the criteria level, the AHP analysis indicates that Organizational Capability carries the highest weight, followed by Location, Operational Requirement and Financial Viability. At the sub-criteria level, Partnership Readiness emerges as the most significant, followed by Manufacturing Supervisor Availability, Prospective Area and Easiness to Build Distribution Network. At the alternative level, Surabaya is the most preferred site, followed by Bogor, Lampung, Batam and Makassar.*

Keywords : Tea Industry; Factory Location; Logistic Efficiency; AHP; MCDM

INTRODUCTION

Tea is one of the commodity plantation products that play a significant economic role in Indonesia. In addition to oil and gas, it is one of Indonesia's most essential exports in terms of foreign currency earnings. In addition to the expanding export opportunities, the domestic tea market is still quite substantial and has not been fully exploited (BPS-Statistics Indonesia, 2021). According to Statista, revenue of Indonesia’s tea segment, consisting of out of home and at home consumption, amounts to US $4.77 billion in 2023. The market's projected Compound Annual Growth Return (CAGR) from 2023 to 2025 is 4.73% yearly growth as being shown in Figure 1.

Furthermore, the projection in Figure 2 indicated that the increasing revenue will result in rising average revenue per capita from $16.92 in 2023 to $18.22 in 2024. The positive trend is going to sustain as long as there’s a constant effort to try to improve the market from several parties such as government and private companies. By 2025, spending on tea will make up 54% of the market and volume consumption will make up 8% of sales made in establishments such as bars and restaurants. But the rest of 92% tea consumption will still belong to at-home consumption (Statista, 2023). Thus, consumption of tea products such as tea bags are going to be solid and companies which produce them will be benefitted. By 2025, volume in the tea segment is anticipated to increase and reach 122.10 million kg as shown in Figure 3.

Witnessing the potential growth of national tea consumption, PT. Surya Sentosa Sejahtera (PT. SSS), producer of tea products in Indonesia, considers a decision of opening a new factory as mandatory to capture the growth. PT. SSS is planning to construct one new tea factory in another city outside Sumatra island because it can help the company to tackle the current biggest issue of high logistic cost and eventually can reach more customers around Indonesia. Currently, the company only has one tea factory operating in Medan, a city located in North Sumatra. Its non-strategic location is the major reason that contributes to higher shipping expenses endured by the firm.

Based on the preliminary interview with the Regional Sales Manager of PT SSS, he shared a difficult case from their recent negotiation with a potential distributor in Lombok. The negotiation faced some challenges due to high shipping costs, which ultimately eroded the profit margin of the company. To transport goods by land from Medan to Lombok (West Nusa Tenggara), the products need to go through Jakarta and Surabaya (East Java) before finally reaching Lombok. This routing, according to the company's internal calculation, was found to incur a 50% higher cost compared to if company's factory is located around Central Java cities.

Company's internal data, as shown in Figure 4, reveals a significant disparity in distribution costs between the current operations from Medan to selected cities like Palembang, Lampung and Surabaya, as compared to the representation of Jakarta, a city in Java, to these same areas. For instance, when shipping from Medan to Palembang, the land freight delivery cost is 21,000 IDR per carton, whereas the same journey from Jakarta only amounts to 15,000 IDR per carton. This results in the company paying 40% more than necessary when compared to having a factory located in Jakarta. A similar cost discrepancy is evident in the Bandar Lampung route where it takes 30,200 IDR per carton to deliver from Medan as opposed to only 10,100 IDR per carton from Jakarta, making it nearly three times cheaper. The same pattern holds true for the "Medan-Batam" and "Medan-Surabaya" routes, where the company must pay nearly double the price compared to direct delivery from Jakarta.

This study aims to find out the most optimal location for PT SSS's new tea factory. The goal is to provide suggestion for company representatives in charge of the project with more scientifically proven method before making decision. Moreover, there is a scarcity of literature on how to determinine the best location for tea factory expansion in the tea beverage industry using appropriate instrument. As a result, the author will try to fill the gap to assist the organization in solving this issue while also addressing the research gap.

LITERATURE REVIEW

Multi-Criteria Decision Making (MCDM)

A technique called "multi-criteria decision making" aids in the decision-making process when there are numerous factors. This particular decision making technique has widespread applications (Alhamzi, et al., 2023), ranging from stock selection, Industry 4.0, manufacturing and construction (Shanmugasunda et al., 2023). Multi-Criteria Decision Making (MCDM) is a method used to select the most favorable choice among a set of options. It helps identify the best alternative when faced with multiple choices and decision criteria to consider. This method proves valuable in situations where the options or decision criteria are diverse and not clearly defined. It is especially beneficial when there are conflicting choices, criteria and varying opinions among decision makers.

The goal of MCDM is to rank alternatives from most to least favored by offering choices, ratings, descriptions, classifications, groupings, and choices (Mulliner & Malys, 2016). All methods for multi-criteria decision-making follow these three steps (Pramanik et al., 2021): 1) Identify and Select the Criteria; 2) Determine the Weights of Resources; 3) Rank the Resources by Using a Suitable MCDM Method.

Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a comprehensive decision-making method that uses a hierarchical structure and considers both quantitative and qualitative criteria. It involves creating a problem hierarchy and using pairwise comparison judgments to assign values to each level (Krejnus et al., 2023). This tool has many different domains of use, but its most widespread uses are in planning, resource allocation, and multi-criteria decision making (Byun, 2001).

It is a method that integrates mathematics and psychology to analyze and organize complex decisions. Since its creation in 1977 by Thomas L. Saaty, it has enhanced.The process of making decisions considered multiple alternatives and was able to incorporate sensitivity analysis to consecutive benchmarks and criteria. Employing paired comparisons also simplifies evaluations and calculations. Further, it demonstrates the compatibility and incompatibility decisions that result from the use of multiple criteria during decision-making. (Taherdoost, 2017).

AHP Approach in Selecting Plant Location

Researchers have acknowledged the significance and effectiveness of MCDM methodologies in tackling the progressively complex issues associated with plant location concerns. (Mousavi et al., 2013). MCDM methods enhance the optimization of facility location decisions by systematically evaluating a spectrum of both qualitative and quantitative criteria (Athawale et al., 2012 and Farahani et al., 2010).

Typically, the responsibility of addressing this issue and defining the evaluation variables lies with a team of experts (Aljohani, 2023). According to Tramarico et al. (2015), AHP is the most commonly used MCDM method in the supply chain management field. Similarly, Paul et al. (2022) acknowledged the prominence of the AHP as the prevailing approach for numerous MCDM in the context of plant location. It is favored due to its ability to integrate qualitative and quantitative data, enabling the ranking of options when many variables should be taken into account.

AHP has numerous applications in location-based decision-making, including the selection of sites for expanding limestone quarries, manufacturing plant locations, upper reservoir sites, restaurant locations, and facility location selections (Dey & Ramcharan, 2008, Jimenez et al., 2015, Mousavi et al, 2013, Tzeng et al, 2002).

RESEARCH METHOD

Method is a method of work that can be used to obtain something. While the research method can be interpreted as a work procedure in the research process, both in searching for data or disclosing existing phenomena (Zulkarnaen, W., et al., 2020:229).

Research Design

A research design refers to the strategy or framework employed to carry out a research investigation (Singh, 2023). Research design as depicted in Figure 5 shows that the problem of expensive logistic cost is identified as the central issue to be resolved. This issue is then explored through a comprehensive literature review that consists of theoretical foundation and conceptual framework of relevant method to solve the issue. It then leads to the proposed solution involving Analytical Hierarchy Process (AHP) tool to determine the most suitable city for opening a new tea factory. Furthermore, data collection will be conducted using questionnaires to gather relevant information, which will then be used to conduct an AHP simulation, a process of weighting the criteria and sub-criteria and quantifying the alternatives. Thus, the result of AHP analysis will provide insights to select the best city for opening tea factory By then, implementation plan and recommendation can finally be provided.

Data Collection Method

In this research, only primary data that is going to be collected. Primary data as the first-hand information has merits such as validity, reliability, objectivity and authenticity compared to secondary data (Taherdoost, Hamed, 2021). The data collection methods in this study consist of:

1. In-depth Interview: In this research, author conducted special interview session with company's top management, especially the Person-in-Charge (PIC) of the project, to do brainstorming discussion about what are the important criteria and sub-criteria in selecting new location for new factory.
2. Questionnaire: This research mainly uses quantitative research with survey method. Quantitative research is the accumulation and analysis of numerical data for the purpose of describing, predicting, explaining or controlling phenomena of interest. Since pairwise comparisons are a step in the AHP, distribution of questionnaires is necessary. Questionnaires are the key data collection methods used in this type of comparison to conduct survey. There are two sections to the questionnaire as shown in Figure 6 and Figure 7. In the first section, criteria and sub-criteria are compared, and in the second section, alternatives related to each criteria and sub-criteria are compared.

Data Analysis Method

To solve the issue, the chosen analytical approach is the Analytical Hierarchy Process (AHP) Method. Data analysis for this particular method starts from conducting the step of issue identification, hierarchy establishment, pairwise comparison and weighting priorities. As the final phase, Kadarshyah and Ali in 2018 also laid few additional steps in conducting AHP analysis (Supriadi et al., 2018):

1. Determine the eigenvalues and examine their consistency. If it is inconsistent, the data collection will be repeated. The computation formulas are:
   - Calculate the Consistency Index (CI) = $\frac{\lambda max - n}{n-1}$; λmax = max eigenvalue; n = size of the matrices
   - Calculate the Consistency Ratio (CR) = $\frac{CI}{RCI}$; RCI = Random Consistency Index; if the Consistency Ratio (CR) is below or equal to 0.1 therefore the comparison

judgement is approved, but if it is more significant than 0.10, it is necessary to update the judgments in order to address the underlying cause of the inconsistency.

2. Repeat the steps such as performing a pairwise comparison matrices, weight the priorities and calculating eigenvalues and testing consistency on each hierarchy;
3. Checking the consistency of the hierarchy: Expected consistency are those reach the perfect range so it can gain valid result;
4. Conduct *synthesis*, by summing up the weights of the common nodes at the bottom of the hierarchy, the relative importance of each alternative to the decision objective at the top may be calculated. Historically, an additive value function has been associated to the AHP (Kamenetzky, 1982):

$$Vi = \sum_{j=1}^{m} VijWj$$

where Vi (i = 1, … , n) are the overall values of decision alternatives; vij (j = 1, … , n) are the values of decision alternatives with respect to (sub)criteria j, and wj (j = 1, … , m) are the weights of decision (sub)criteria.

5. Determine the alternative or the choice

RESULT AND DISCUSSION

To gather pairwise comparison data, the author distributed this closed-ended questionnaire to a total of five respondents who are in charge of the project and have more than ten years experience in Food and Beverage Industry. The positions of chosen experts are Regional Sales Manager, Area Sales Manager, Area Sales Supervisor, Manufacturing Manager and Marketing Manager. According to Saaty, it is important for these judgments to not only consider knowledge of the influences but also the degree of strength with which these influences manifest (Saaty, 2008).

After some consideration, the framework for AHP was established by conducting in-depth interview with PIC and referring to scholarly journal on similar topic as shown in Table 1. As the result, first level thus reflects the decision-making end-goal to select the most favorable city out of them. The second level of significant criteria, which includes *Financial Viability*, *Location*, *Operational Requirements* and *Organizational Capability* should be taken into account after the goal.

The third level, known as sub-criteria, is formed by each criterion being made into a more precise aspects as depicted in the Figure 8. The *Financial Viability* criteria is divided into four sub-criteria which are *Land Price*, *Construction Fee* and *Wage* and *Administrative Expense*. While *Location* criteria has five sub-criteria such as *Near Port*, *Easiness to Build Distribution Network*, *In the Suburbs*, *Prospective Area* and *Well-Established Infrastructure*. Furthermore, the *Operational Requirement* criteria consists of *Maintenance Services Availability* and *Spare Parts Accessibility* as the sub-criteria, as well as criteria of *Organizational Capability* that consists of two sub-criteria like *Manufacturing Supervisor Availability* and *Partnership Readiness*. To understand better, the definition of each criteria and sub-criteria are provided in Table 2.

Furthermore, the survey questionnaire and data processing procedures are conducted using a web-based AHP tool, which can be accessed via the following link: https://bpmsg.com/ahp/. This tool was developed by Klause D. Goepel for supporting decision making processes (Goepel, 2018).

Outcome of Pairwise Comparison for Criteria and Sub-criteria

In the first phase, the data collected from the experts was analysed in accordance with the required methodology. The weights for each local criterion and the global weights for sub-criteria were determined and are presented in Table 3. The Consistency Ratio for each matrix of sub-criteria confirmed that the evaluations for the four criteria were consistent (Financial Viability = 0.001; Location = 0.032; Operational Requirement = 0.0; Organizational Capability = 0.0).

Based on the research findings, there are four (4) sub-criteria that hold a dominant influence, accounting for 69.6% out of the total 100% of sub-criteria, in the selection process for the new tea factory location, which are: 1) *Partnership Readiness* accounts for 21%; 2) *Manufacturing Supervisor Availability* accounts for 19%; 3) *Prospective Area* accounts for 15.1%; and 4) *Easiness to Build Distribution Network* accounts for 14.5%.

Outcome of Pairwise Comparison for Sub-Criteria with Alternative

The second questionnaire is administered to the same group of participants or experts who provided judgements on the initial questionnaire. This process yields a priority index for the alternatives, which serves as an indicator of how well each alternatives aligns with the various sub-criteria as shown in Figure 9.

Based on the result of the consolidated matrix, it can be inferred that:

1. Surabaya is the most favored alternative with the percentage of 38.6%;

2. Bogor is the second option with the percentage of 18.4%;
3. Lampung is the third option with the percentage of 16.7%;
4. Batam is the fourth option with the percentage of 15.7%; and
5. Makassar is the least favored option with the percentage of 10.5%.

Additionally, the AHP Decision Hierarchy depicted in Figure 10 provides further elaboration on the sub-criteria that offers the most favorable support or advantages for each alternative. In this study, Surabaya emerged as the leading city because of its superior performance in various crucial sub-criteria that hold significant global importance. These include the sub-criteria of *Easiness to Build Distribution Network, Prospective Area*, *Manufacturing Supervisor Availability* and *Partnership Readiness* that only account for 69.6% of global priority.

However, Bogor is currently ranked as the second most desirable city, mostly excelling in less significant sub-criteria such as *In the Suburbs* with global priority of only 1.7%, while only ranking as the second on *Manufacturing Supervisor Availability* and *Partnership Readiness* sub-criteria. The aforementioned pattern is also observed in the case of Lampung, where it is shown to achieve success mostly in low priority global sub-criteria like *Near Port* (4.5%), while Batam leading in terms of *Spare Parts Accessibility* (7.4%) and Makassar performing well in the category of *Wage and Administrative Expense* (4.6%).

Discussion on Criteria and Sub-criteria Weights

Based on the findings from Analytical Hierarchy Process (AHP), the highest priority of the criteria is *Organizational Capability* (40%). It means that *Manufacturing Supervisor Availability* and *Partnership Readiness* as part of the criteria are considered very crucial for selecting location. The discussion with PIC revealed that the need for manufacturing supervisors stems from the standard operating procedure (SOP) of the factory, which emphasizes the elimination of human error. This is because seventy percent (70%) of production is still performed by humans and is not fully automated.

Partnership Readiness is essential for generating demand among previously hard-to-reach potential customers. There is little demand for the product outside of North Sumatra because of the high shipping costs and the required quantities are not met. Typically, the distributors are unable to accept a full container because their selling capacity is only around ¼ or a quarter of a container per month. However, if the company tries to deliver using partial shipments from Medan, it will cost them around 120,000 IDR per carton, which is four times more expensive than using full container shipment that costs around 30,000 IDR per carton. These are the challenges faced by both parties and only can be solved by having reliable logistic partners who can provide partial shipment services.

Location (38.9%) has the second greatest priority of all criteria. The PIC revealed that the company always prioritizes regions where it is simple to establish a distribution network, particularly due to the presence of potential distributors or agents and numerous logistic providers. If there are many manufacturing facilities in an area, there is a good chance that logistic services also exist. This may result in increased competition between those logistic companies, which will benefit PT SSS by lowering shipping rates. Additionally, location with promising future prospects is essential. It is reflected by the number of inhabitants in the region. The greater the population density, the better, as the company can ride the wave of expanding demand.

According to the interviewee, *Operational Requirement* (13.9%) as the third most important criteria is still important although it is not too dominating. The possible explanation for its ranking is that maintenance services will be readily accessible at the selected location. This is made possible by the company's preliminary screening procedure, which ensures that each selected location is within or in close proximity to an industrial hub containing numerous factories. This method of selection improves the likelihood of quickly locating maintenance services. Moreover, the chosen location should have convenient access to spare parts, particularly in the event of machine failure. This precautionary measure is implemented to avert any potential delays in production, ensuring seamless operations.

Notably, the interview provided insight into why *Financial Viability* was deemed the least significant factor. The PIC clarified that the company regards it as a necessary investment cost. Furthermore, the PIC emphasized the significance of considering the land's long-term value, not just its short-term value. He even acknowledges that the company's calculations indicate that the involvement of third-party entities such as banks is quite conceivable, given that its projected profitability is sufficient to cover its capital and interest. For the wage expense, management views it as not too crucial. It is due to the fact that management has an outlook on the future that is centered on the reduction of daily tasks that require human labor.

Discussion on the Outcome of Alternative

According to management, Surabaya's strategic location has led to the emergence of numerous logistic players offering a variety of services, particularly partial container load or "Less than Container Load" that allows shippers to share containers with other parties and pay only for the space used. Moreover, the high level of competition between logistic providers enables companies to obtain lower shipping costs. By then, the company could allocate the money being saved to create additional programs for distributors to get them to work or enter into partnership.

In addition to the region's capacity to reach a variety of locations throughout Indonesia, Surabaya is also notable for the high concentration of industrial jobs in the city, which has emerged as a significant influencer. It is because Surabaya is one of the largest industrial cities in terms of its factory plant. As a result, a large number of relevant talents are circulating among those areas, and the company has a larger potential to get one of the most talented and experienced workers, particularly a manufacturing supervisor, in that territory.

CONCLUSION

Based on the previous design and analysis results, a structured conclusion of the research findings is presented at this stage:

1. This research accordingly develops four (4) important criteria in selecting location to open new plant, which are *Financial Viability*, *Location*, *Operational Requirement* and *Organizational Capability* and twelve (12) sub-criteria composing *Land Price*, *Construction Fee*, *Wage and Administrative Expense*, *Near Port*, *Easiness to Build Distribution Network*, *In the Suburbs*, *Prospective Area*, *Well-established Infrastructure, Maintenance Services Availability*, *Spare Parts Accessibility*, *Manufacturing Supervisor Availability* and *Partnership Readiness* which are going to be compared five (5) alternative locations consisting Batam, Bogor, Lampung, Makassar and Surabaya.
2. The study employed the Analytical Hierarchy Process (AHP) tool in order to determine the relative significance of each criterion and sub-criterion. The process then entails the examination of twelve (12) sub-criteria via a pairwise comparison

matrix, followed by the determination of the priority (weightage) of each individual aspect with respect to each available alternative. This is accomplished by distributing surveys to five (5) carefully chosen respondents to gather their expert opinions.

3. Based on a survey conducted by experts employed by the organization, it has been determined that Surabaya is the most optimal location for establishing a new tea manufacturing facility. Following Surabaya, Bogor is the city with the second-most favorable option, succeeded by Lampung in the third, Batam in the fourth, and ultimately Makassar, which is perceived to have the least preferred location.

Following the completion of the analysis of the findings of the pairwise comparisons based on the opinions of the experts, there are a number of suggestions that can be made as the outcomes of this study. Firstly, it is imperative for companies to prioritize key criteria when making decisions in order to prevent being overwhelmed by a multitude of potentially insignificant factors. It is also crucial that all stakeholders actively participate and demonstrate a willingness to collaborate to ensure the successful execution of the project. Then, for a smooth transition to the new tea manufacturing site, the execution plan must be followed precisely.

Moreover, Further study is necessary to assess the validity of the approach employed in this work. The quality of the decision can be enhanced by incorporating additional indicators and parameters, which can effectively capture the precise criteria and sub-criteria associated with selecting a suitable industrial location. In future research endeavors, it would be beneficial to employ this methodology to evaluate alternative plant sites or those with similar project objectives when establishing new manufacturing facilities in different locations.

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FIGURES, GRAPHS AND TABLES

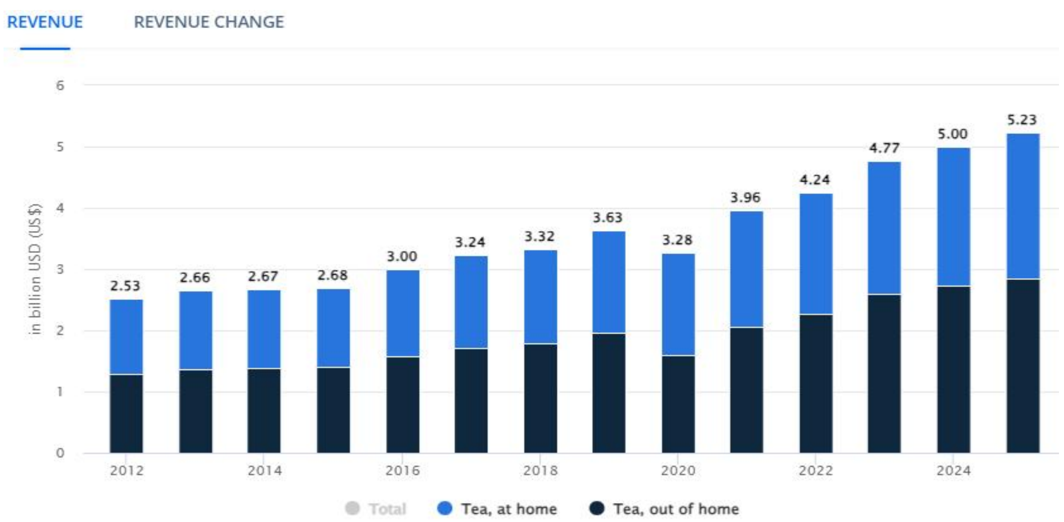

Figure 1. Revenue of Indonesia's Tea Segment
Source: Statista Market Insights (2023)

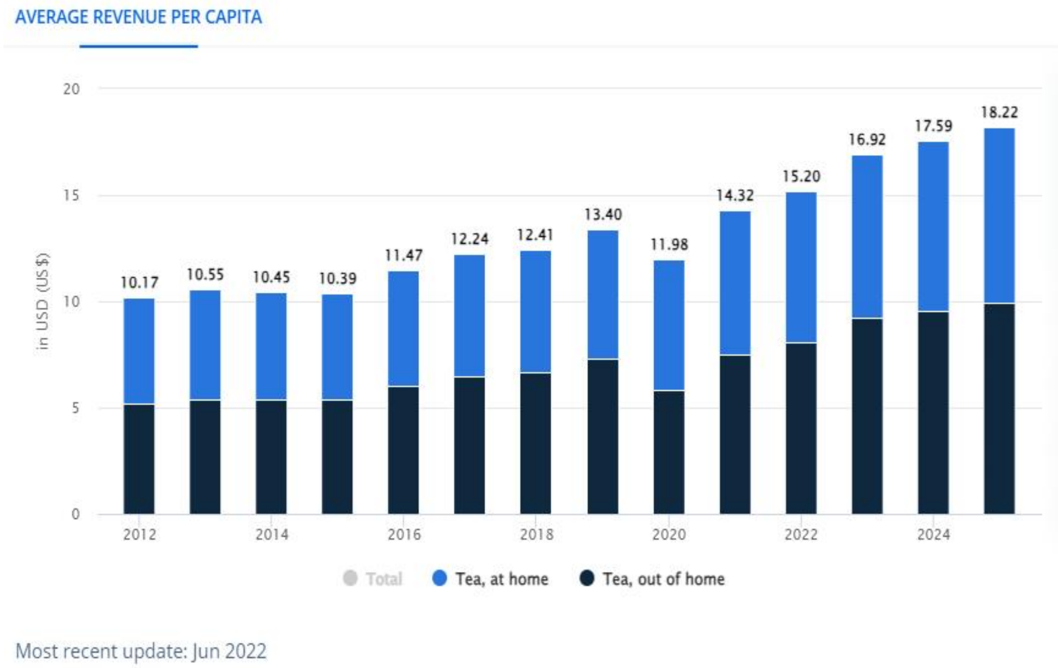

Figure 2. Average Tea Revenue Per Capita in Indonesia
Source: Statista Market Insights (2023)

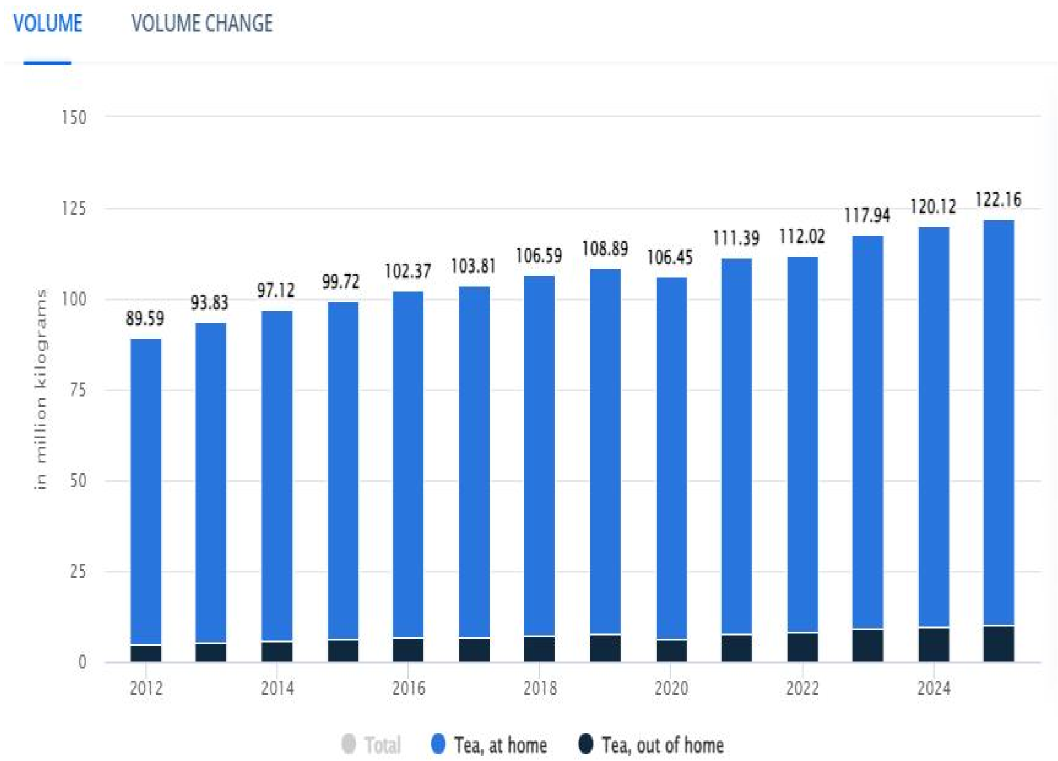

Figure 3. Volume of Tea Consumption in Indonesia
Source: Statista Market Insights (2023)

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Figure 4. Logistic Cost Comparison
Source: Company's Internal Data (2023)

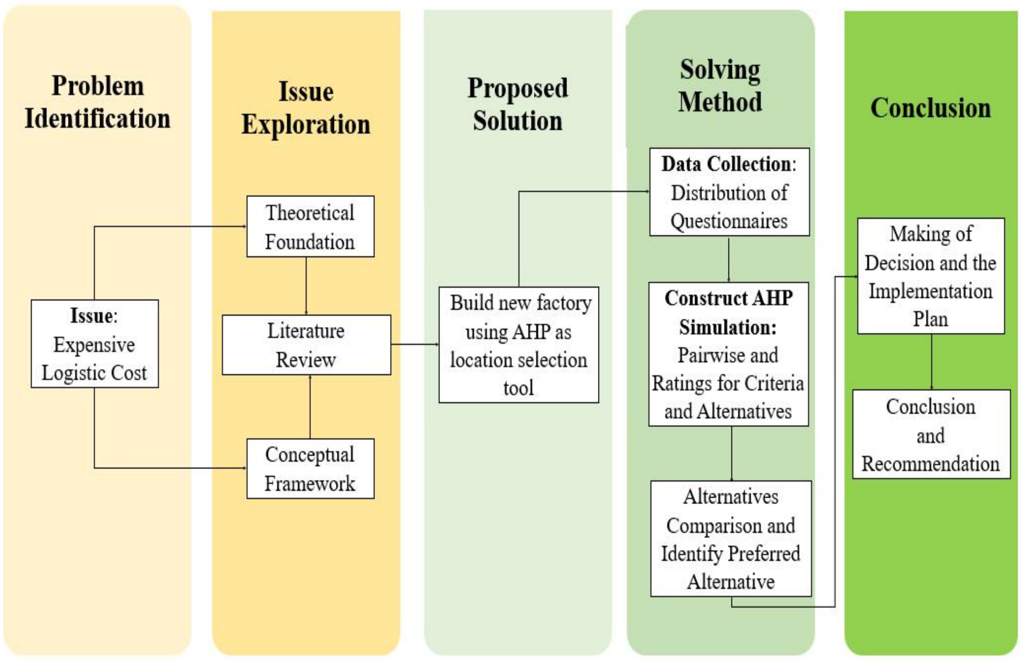


Figure 5. Research Design

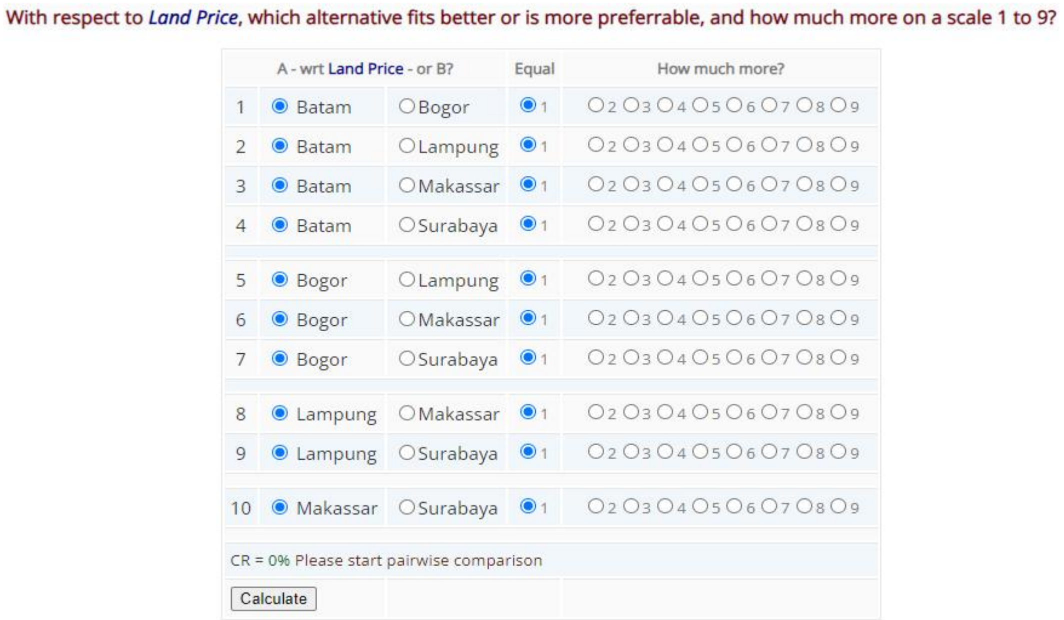
With respect to *Selecting best location for new tea factory*, which criterion is more important, and how much more on a scale 1 to 9?

	A - wrt **Selecting best location for new tea factory** - or B?		Equal	How much more?
1	Financial Viability	Location	1	2 3 4 5 6 7 8 9
2	Financial Viability	Operational Requirement	1	2 3 4 5 6 7 8 9
3	Financial Viability	Organizational Capability	1	2 3 4 5 6 7 8 9
4	Location	Operational Requirement	1	2 3 4 5 6 7 8 9
5	Location	Organizational Capability	1	2 3 4 5 6 7 8 9
6	Operational Requirement	Organizational Capability	1	2 3 4 5 6 7 8 9

CR = 0% Please start pairwise comparison

Calculate

Figure 6. Questionnaire for Pairwise Comparison of Criteria
Source: https://bpmsg.com/ahp/



With respect to *Land Price*, which alternative fits better or is more preferrable, and how much more on a scale 1 to 9?

	A - wrt **Land Price** - or B?		Equal	How much more?
1	Batam	Bogor	1	2 3 4 5 6 7 8 9
2	Batam	Lampung	1	2 3 4 5 6 7 8 9
3	Batam	Makassar	1	2 3 4 5 6 7 8 9
4	Batam	Surabaya	1	2 3 4 5 6 7 8 9
5	Bogor	Lampung	1	2 3 4 5 6 7 8 9
6	Bogor	Makassar	1	2 3 4 5 6 7 8 9
7	Bogor	Surabaya	1	2 3 4 5 6 7 8 9
8	Lampung	Makassar	1	2 3 4 5 6 7 8 9
9	Lampung	Surabaya	1	2 3 4 5 6 7 8 9
10	Makassar	Surabaya	1	2 3 4 5 6 7 8 9

CR = 0% Please start pairwise comparison

Calculate

Figure 7. Questionnaire for Pairwise Comparison of Alternatives with respect to "Land Price" sub-criteria
Source: https://bpmsg.com/ahp/

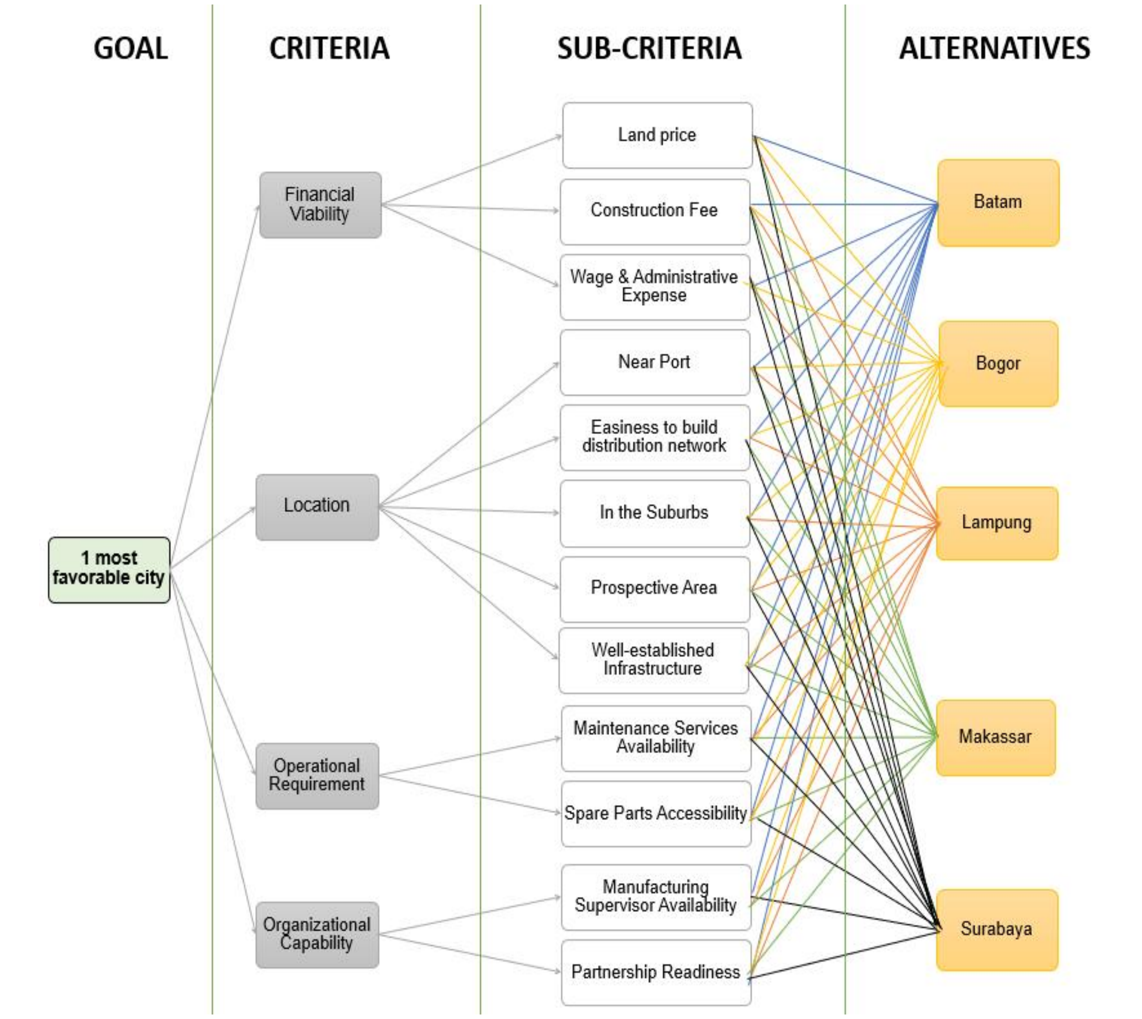


Figure 8. Conceptual Framework of AHP Method

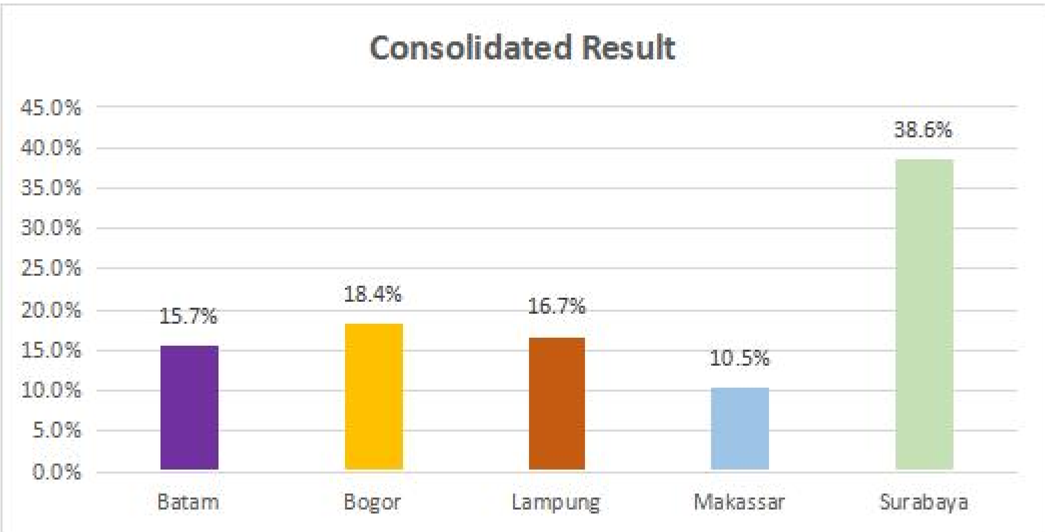


Figure 9. Consolidated Weights of Alternatives

Figure 10. Hierarchy with Consolidated Priorities for Alternatives

Table 1. Scholarly References for Criteria and Sub-Criteria

Journal	Criteria
Journal of optimizing the distribution network of bakery facility (Aljohani, 2023)	- Investment costs, - transportation infrastructure, - availability of area, - accessibility to production resources, - nearness to essential utilities, - proximity to adjacent facilities, - proximity to target markets, and - closeness to raw materials
Journal for shirt factory selection (Hakim & Putra, 2022)	- Cost, - population, - geography risk - facilities and infrastructure, - availability of human resources and - developer credibility
Journal for evaluating location selection elements for retail store (Akalin, et al., 2013)	- Cost - Population - retail settlement - competition

Table 2. Description of Criteria and Sub-criteria

CRITERIA	SUB-CRITERIA	DEFINITION
Financial Viability		The evaluation of the tea factory project to ensure it remains economically feasible and profitable
	Land Price	The cost of acquiring land for the tea factory
	Construction Fee	The expenses associated with building the tea factory infrastructure, such as building and necessary facilities.
	Wage & Administrative Expense	The costs associated with hiring and managing employees, as well as other administrative and operational expenses
Location		The geographical placement of the tea factory
	Near Port	Near port signifies the proximity of the tea factory to a seaport which can reduce transportation cost and lead times.
	Easiness to build distribution network	Evaluation of how easily the factory can establish efficient distribution channel for its tea products to reach customers.
	In the Suburbs	Locating in suburban areas can offer cost advantages such as lower fuel consumption due to less traffic jam.
	Prospective Area	The population growth and development of the area where the tea factory will be established
	Well-estabished infrastructure	The availability of good transportation, utilities and other supporting facilities in chosen location.
Operational Requirement		Operational requirement deals with the necessary conditions for smooth tea factory operations.
	Maintenance Services Availability	The accesibility of skilled professionals and service providers to maintain and repair the tea factory's machinery and equipment.
	Spare Parts Accessibility	Relating to the easiness of obtaining spar parts for machinery and equipment for minimizing downtime during equipment breakdowns.
Organizational Capability		Organizational Capability evaluates the tea factory's capacity to manage and run the business successfully.
	Manufacturing Supervisor Availability	Examining the availability of competent and experienced supervisors to oversee the tea production process efficiently.
	Partnership Readiness	Company's capability to establish partnerships with stakeholders (e.g. logistic company) to enhance market reach.

Table 3. Relative Weights of Criteria and Sub-criteria with Respect to the Goal

Level 0	Level 1		Level 2		Global
Goal	Criteria	Local Weight	Sub-Criteria	Local Weight	Weight
Selecting best location for new tea factory	Financial Viability	0.072	Land Price	0.214	0.015
			Construction Fee	0.142	0.001
			Wage and Administrative Expense	0.644	0.046
	Location	0.389	Near Port	0.117	0.045
			Easiness to build Distribution Network	0.374	0.145
			In the Suburbs	0.042	0.017
			Prospective Area	0.388	0.151
			Well-established Infrastructure	0.079	0.031
	Operational Requirement	0.139	Maintenance Services Availability	0.471	0.065
			Spare Parts Accessibility	0.529	0.074
	Organizational Capability	0.4	Manufacturing Supervisor Availability	0.474	0.19
			Partnership Readiness	0.526	0.21