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Mapping Coconut's Stakeholders Decision Strategy toward Supply Chain Sustainability Goal.

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ABSTRACT

The significance of sustainable supply chains within the agriculture sector is paramount in ensuring the effective execution of sustainable development initiatives in the forthcoming period. Nevertheless, the research focuses predominantly on developed nations, with limited attention given to developing countries such as Indonesia. The objective of this study is to propose critical factors for evaluating the sustainability of a coconut supply chain concerning its economic and social aspects. A combination of an interview and a literature study was conducted. A comprehensive analysis revealed the existence of 37 factors, with 17 pertaining to the economic dimension and 20 linked to the social dimension. A panel of five experts validated the assessment of the content validity of the factors. The Content Validity Ratio (CVR) approach was applied to determine the validation of the instrument. Twelve factors related to the economy and four associated with the social dimension have a higher 0.99. For the reliability test using interclass correlation coefficient (ICC) score is 0.906 (reliable). The Analytical Hierarchy Process (AHP) was employed to determine the weight of critical factors. Based on the result, it can be concluded that the economic aspects exhibit a more significant proportion than the social dimension. The novelty of this study lies in calculating the importance of the critical factors and how the AHP technique can assess initiatives supporting the SDGs that farmers should highly consider to change the way they decide and map the supply chain strategy earlier toward sustainability in the future.

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1. INTRODUCTION

In the contemporary era characterized by globalization and heightened awareness, the concept of sustainability has assumed paramount importance within the domain of supply chain management. A sustainable supply chain is characterized by the incorporation of environmental, social, and economic factors into its operational framework, with the aim of mitigating adverse effects and optimizing beneficial contributions to economic, society and the environment. In order to effectively attain sustainability goals, decision-makers want defined approaches to take decision wisely and tools that can assist in prioritizing and aligning supply chain strategies with sustainability objectives.

In recent decades, the issue of sustainability has emerged as a prominent global concern. Business or farmers or related stakeholders are compelled to reconsider their supply chain strategy due to the presence of social and economic sourcing concerns and industry revolution 5.0 where Society 5.0 has characteristics focused on human aspects and makes it the cornerstone of its development, open, sustainable and inclusive, as well as strongly driven by many attempts to continuously improve life.

Sustainable supply chains have a multitude of advantages, encompassing risk mitigation, financial savings, brand augmentation, and adherence to regulatory requirements. Consequently, there is a growing acknowledgment among firms regarding the significance of incorporating sustainability concepts inside their supply chain operations.

There are many multi decision criteria decision making (MCDM) used by previous research in sustainable supply chain [1] 2]. However, the Analytic Hierarchy Process (AHP) is an example of a tool that can be used in this context. AHP is a well-established and widely accepted method for making decisions based on several criteria. It has been extensively utilized in various fields [3]–[8] [9]. The AHP offers a systematic framework for evaluating and ranking intricate decision factors, rendering it a suitable instrument for tackling sustainability concerns in supply chains.

2. METHODS

In this research, the proposed coconut farmers strategy is used to design a strategy to produce a sustainable supply chain based on economic and social aspects. Steps in determining criteria using the AHP method using Super Decision software and Microsoft excel.

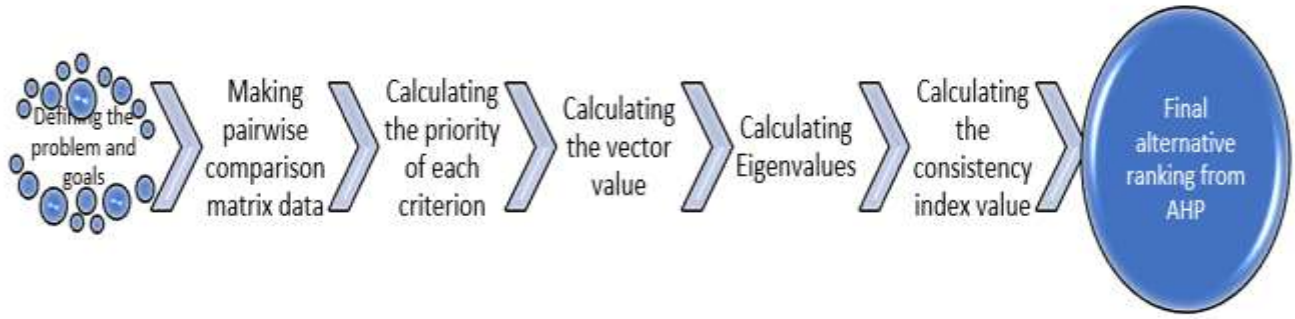

Figure 1. Steps to determine sustainable supply chain strategy

The consistency ratio (CR) is calculated to determine the consistency of experts' judgments. The CR is a ratio between the matrix's consistency index and random index and in general varies from 0 to 1. A CR of 0.1 or less is considered acceptable [10]. A value of CR above 0.1 requires the revision of judgments in the matrix due to an inconsistent treatment for particular factor ratings. The CR is calculated as shown in the following equation: The CR is expressed by the consistency index (CI) and random index (RI):

$$CR = \frac{CI}{RI} \quad (1)$$

The CR of a pairwise comparison matrix is the CI's ratio to the corresponding RI value in Table 1. The CI of a matrix can be expressed as:

$$CI = \frac{(\lambda max - n)}{(n-1)} \quad (2)$$

The CI for a judgment matrix can be computed as a function of its maximum eigenvalue λ_{max} and the order n of the matrix. The judgment matrix is reliable if the CR value is smaller than 0.1. However, when the CR value is more extensive than 0.1, the judgment matrix's result is viewed as unreliable, and the judgment matrix must be revised [10], [11]).

Table 1. Random Index (RI)

Attributes	1	2	3	4	5	6	7	8	9	10
RI	0.0	0.0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

AHP is used to break down multi criteria decision making into stages that are easy to understand. At each level, the criteria are compared in pairs according to selected journal to their level of influence and based on criteria determined at higher levels. In AHP, multiple pairwise comparisons are based on a comparison scale. Basically, the multi-criteria mathematical formulation with the AHP model is carried out using a matrix.

To produce good decisions, there are several stages carried out in this research. The first stage is to conduct a field survey at the research object and then search for information by looking for data related to conditions in the field. The second stage is conducting in-depth interviews with stakeholders to explore information and the relationship between the aspects found in the literature review and conditions in the field. The third stage is to validate and confirm with experts in the field of supply chain sustainability, supply chain experts and coconut buying and selling businesses players. The fifth stage is to carry out a content validity test to determine expert agreement in determining the aspects that have been determined. The 6th stage is to carry out a content validity test using CVR. From the number 17 indicators of economic aspects and 20 social aspects it becomes 12 indicators for economy and 4 for social receptively.

The criteria and sub-criteria in this study are the criteria and sub-criteria used by the farmers selecting strategy to predict the future action. Analytical Hierarchy Process overcome the problem with the approach of weight (weight) and scores (value). This is done by structuring complexity as a hierarchy and measuring ratio scales through pairwise relative comparisons. The use of redundancy allows accurate priority to be taken from verbal judgments. We can use words to compare qualitative factors and obtain priority scale ratios that can be combined with quantitative factors. Using the AHP pairwise comparison process, the weights or priorities are obtained from a set of judgments. When it is difficult to justify an arbitrary weight set, it is actually relatively easy based on the raw data, knowledge, and experience of the decision. This weight or priority is a measurement of the ratio level, not calculated. From the weighting obtained using the super decision application, the resulting graph Table III regarding the comparison between the criteria as follows.

3. RESULTS AND DISCUSSION

The completion steps using super decisions and Microsoft Excel software are as follows. Structure of the decision hierarchy. This section provides an overview of the selected case studies, the data collection and questionnaire design, and the structure of the proposed decision hierarchy for AHP analysis.

3.1 Data collection: questionnaire survey and interview

Data was collected using deep interview with stakeholders. Before the critical indicators were distributed to purposive respondents, content validity was performed to validate the identified factors. Based on content validity ratio (CVR) method only 17 pertaining to the economic dimension and 20 linked to the social dimension were valid. 12 factors related to the economy and four associated with the social dimension have a higher 0.99 table 2.

3.2 Selected performance indicators and structure of the decision hierarchy

The CVR (content validity ratio) proposed by Lawshe (1975) is a linear transformation of a proportional level of agreement on how many “experts” within a panel rate an item “essential” calculated in the following way:

$$CVR = \frac{n_e - (N/2)}{N/2} \qquad (3)$$

where CVR is the content validity ratio, n_e is the number of panel members indicating an item “essential,” and N is the number of panel members table 2.

Table 2: Validity result using CVR

No	Dimension	Level	Indicators	VALIDATOR						Lawshe's CVR	
				E01	E02	E03	E04	E05	Ne	Index CVR	Category
1	Eco-01	Strategic	Investment costs	4	2	4	3	3	**4**	**0.60**	**Not valid**
2	Eco-02	Strategic	Supplier Selection Costs	1	1	1	1	1	**0**	**-1.00**	**Not valid**
3	Eco-03	Strategic	Logistics Costs	4	4	4	4	4	**5**	**1.00**	**valid**
4	Eco-04	Strategic	Common clear vision of supply chain management	2	1	2	2	2	**0**	**-1.00**	**Not valid**
5	Eco-05	Strategic	Innovation potential	2	1	1	1	1	**0**	**-1.00**	**Not valid**
6	Eco-06	Tactical	Capacity utilization	4	4	4	4	4	**5**	**1.00**	**valid**
7	Eco-07	Tactical	Perceived value of product	4	4	4	4	4	**5**	**1.00**	**valid**
8	Eco-08	Tactical	Improved overall profitability and revenue growth.	4	4	4	4	4	**5**	**1.00**	**valid**
9	Eco-09	Operational	Operational costs	4	4	3	3	3	**5**	**1.00**	**valid**
10	Eco-10	Operational	Customer satisfaction rates	4	4	4	4	4	**5**	**1.00**	**valid**
11	Eco-11	Operational	Production Efficiency	4	4	3	3	3	**5**	**1.00**	**valid**
12	Eco-12	Operational	Inventory costs	4	4	4	4	3	**5**	**1.00**	**valid**
13	Eco-13	Operational	Production flexibility	4	4	3	3	3	**5**	**1.00**	**valid**
14	Eco-14	Operational	Information sharing about customer requirements and design plans	2	4	3	2	2	**2**	**-0.20**	**Not valid**
15	Eco-15	Operational	Use of information technologies	3	4	3	3	3	**5**	**1.00**	**valid**
16	Eco-16	Operational	Availability of raw material	4	4	4	4	4	**5**	**1.00**	**valid**
17	Eco-17	Operational	Appropriate Coconut price	4	4	4	4	4	**5**	**1.00**	**valid**
18	Soc-01	Strategic	Employment creation rates	1	1	1	1	1	**0**	**-1.00**	**Not valid**
19	Soc-02	Strategic	Training Rates	4	4	4	4	4	**5**	**1.00**	**valid**
20	Soc-03	Strategic	Adoption of Safety Practices	2	4	3	3	3	**4**	**0.60**	**Not valid**
21	Soc-04	Strategic	Timely and legally paying taxes and associated charges	1	4	1	1	1	**1**	**-0.60**	**Not valid**
22	Soc-05	Strategic	Applying ethical norms of business and trade	1	3	2	2	2	**1**	**-0.60**	**Not valid**
23	Soc-06	Tactical	Customer Retention	4	4	4	4	4	**5**	**1.00**	**valid**
24	Soc-07	Tactical	Labor Equity	2	3	3	3	3	**4**	**0.60**	**Not valid**
25	Soc-08	Tactical	Quality of employee life	1	4	3	2	3	**3**	**0.20**	**Not valid**
26	Soc-09	Operational	Labor efficiency	3	4	3	3	3	**5**	**1.00**	**valid**
27	Soc-10	Operational	Injury prevention	1	3	3	3	3	**4**	**0.60**	**Not valid**
28	Soc-11	Operational	Stakeholders' involvement	1	3	3	3	3	**4**	**0.60**	**Not valid**
29	Soc-12	Operational	Employing the local community	1	1	1	1	1	**0**	**-1.00**	**Not valid**
30	Soc-13	Operational	local community	1	4	3	2	3	**3**	**0.20**	**Not valid**
31	Soc-14	Operational	Ensuring Human rights	1	4	2	2	3	**2**	**-0.20**	**Not valid**
32	Soc-15	Operational	Child and forced labor avoidance	2	4	3	3	3	**4**	**0.60**	**Not valid**
33	Soc-16	Operational	Establish long-term partnerships with suppliers	2	3	3	3	3	**4**	**0.60**	**Not valid**
34	Soc -17	Operational	Wage Ratio	4	4	4	3	4	**5**	**1.00**	**valid**
35	Soc-18	Operational	Gender Equality	1	4	2	2	2	**1**	**-0.60**	**Not valid**
36	Soc-19	Operational	Labor practices and decent work	1	3	2	2	3	**2**	**-0.20**	**Not valid**
37	Soc-20	Operational	human right	1	4	2	2	3	**2**	**-0.20**	**Not valid**

Soc: Social Eco : Economic

Table 3: Intraclass Correlation Coefficient (ICC)

	Intraclass Correlation[b]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.662[a]	.512	.789	13.363	36	144	.000
Average Measures	.907[c]	.840	.949	13.363	36	144	.000

Two-way mixed effects model where people effects are random and measures effects are fixed.
a. The estimator is the same, whether the interaction effect is present or not.
b. Type A intraclass correlation coefficients using an absolute agreement definition.
c. This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

The results presented that the mean interclass correlation coefficient of five validators was excellent (r=0.907 CI 0.840-0.949) test-retest reliability showed high interclass correlation.

3.3 AHP-based performance measurement scheme.

This section discusses the ranking analysis of indicators and elaborates on the development of the performance measurement. We demonstrated an example of the application of the proposed performance measurement scheme using super decision software.

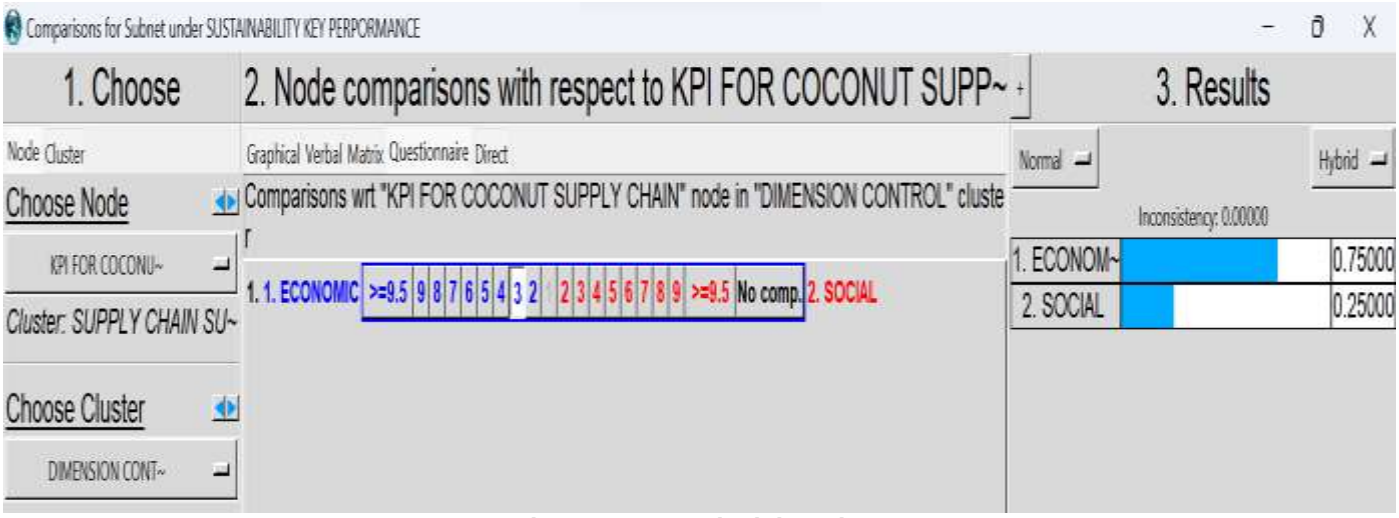

Figure 1 Super decision view

The essential criteria can be investigated and observed among any cluster elements using the weights obtained in this section. The priority of criteria can be defined using the weights in the columns "total weight (limiting)" and "normalized weights by the cluster."

The results obtained show the expert's consensus regarding the previous rater agreements in two Geometric mean agreements. The outcome of the limiting priorities is grouped into four outcomes; the geometric mean of all experts, regulators, practitioner and combination of them. Normalized by cluster based on group judgment table 4.

Table 4. Normalized by Cluster based on group judgment

Name of Indicators	ALL	Experts	Regulators	Practitioners
1. ECONOMIC	0.7500	0.7500	0.7500	0.66667
2. SOCIAL	0.2500	0.2500	0.2500	0.33333
1.1. Strategy For Eco	0.5000	0.53962	0.5000	0.50000
1.2. Tactical For Eco	0.2500	0.29696	0.2500	0.25000
1.3. Operational For Eco	0.2500	0.16342	0.2500	0.25000
2.1 Strategy for Soc	0.3488	1.0000	1.0000	1.0000
2. 2 Tactical for Soc	0.4836	0.2500	0.4000	0.25992
2.3 Operational for Soc	0.1677	0.2500	0.4000	0.32748
1.1.1 Logistic Cost	1.0000	0.5000	0.2000	0.4126
1.2.1 Capacity utilization	0.3333	0.15432	0.16667	0.18181
1.2.2 Perceived value of product	0.3333	0.08613	0.08333	0.18181
1.2.3. Improved overall profitability and revenue growth.	0.3333	0.1648	0.16667	0.09091
1.3.1 Operational costs	0.1538	0.15432	0.08333	0.09091
1.3.2 Customer satisfaction rates.	0.0769	0.09289	0.16667	0.09091
1.3.3 Production Efficiency.	0.1538	0.08239	0.08333	0.09091
1.3.4 Inventory costs.	0.1538	0.09289	0.16667	0.18181
1.3.5 Production flexibility	0.0769	0.17226	0.08333	0.09091
1.3.6 Use of information technologies	0.0769	0.51713	0.33333	0.4126
1.3.7 Availability of raw material	0.1538	0.35856	0.33333	0.32748
1.3.8 Appropriate Coconut price	0.1538	0.12431	0.33333	0.25992
2.1.1 Training Rates	1.0000	1.0000	1.0000	1.0000
2.2.1 Customer Retention	1.0000	1.0000	1.0000	1.0000
2.3.1 Labor efficiency	0.5000	0.66667	0.5000	0.5000
2.3.2 Wage Ratio	0.5000	0.33333	0.5000	0.5000

3.4 Ranking of KPIs based on Sustainable supply chain perspectives for coconut for all respondents

Table 5: The weight of Indicators

Dimension	Weight	Indicators	Local Weight		Global Weight
Economic	0.75	**1.1. Strategy For Eco**	0.5		**0.37500**
		1.1.2 Logistic Cost		1	0.37500
		1.2. Tactical For Eco	0.25		**0.18750**
		1.2.1 Capacity utilization		0.3333	0.06249
		1.2.2 Perceived value of product		0.3333	0.06249
		1.2.3. Improved overall profitability and revenue growth.		0.3333	0.06249
		1.3. Operational for Eco	0.25		0.18750
		1.3.1 Operational costs		0.1538	0.02884
		1.3.2 Customer satisfaction rates.		0.0769	0.01442
		1.3.3 Production Efficiency.		0.1538	0.02884
		1.3.4 Inventory costs.		0.1538	0.02884
		1.3.5 Production flexibility		0.0769	0.01442
		1.3.6 Use of information technologies		0.0769	0.01442
		1.3.7 Availability of raw material		0.1538	0.02884
		1.3.8 Appropriate Coconut price		0.1538	0.02884
Social	0.25	**2.1 Strategy for Soc**	0.3488		0.08720
		2.1.1 Training Rates		1	0.08720
		2. 2 Tactical for Soc	0.4836		0.12090
		2.2.1 Customer Retention		1	0.12090
		2.3 Operational for Soc	0.1677		0.041925
		2.3.1 Labor efficiency		0.5	0.0209625
		2.3.4 Wage Ratio		0.5	0.0209625

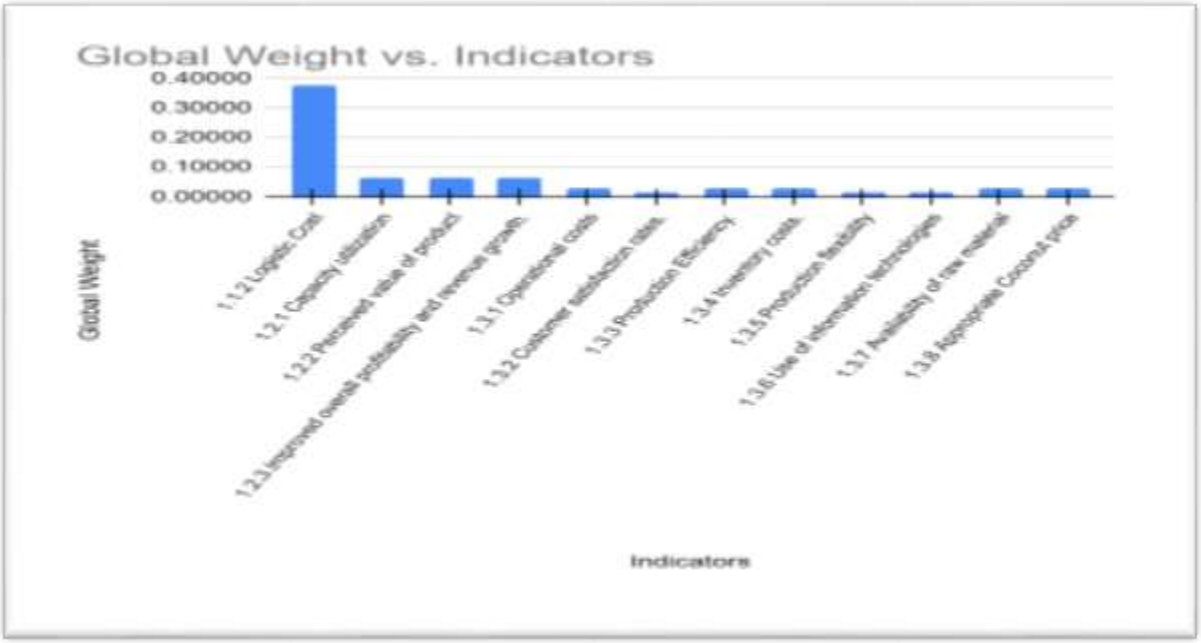

Figure 2 Global Weight for Economic Factors

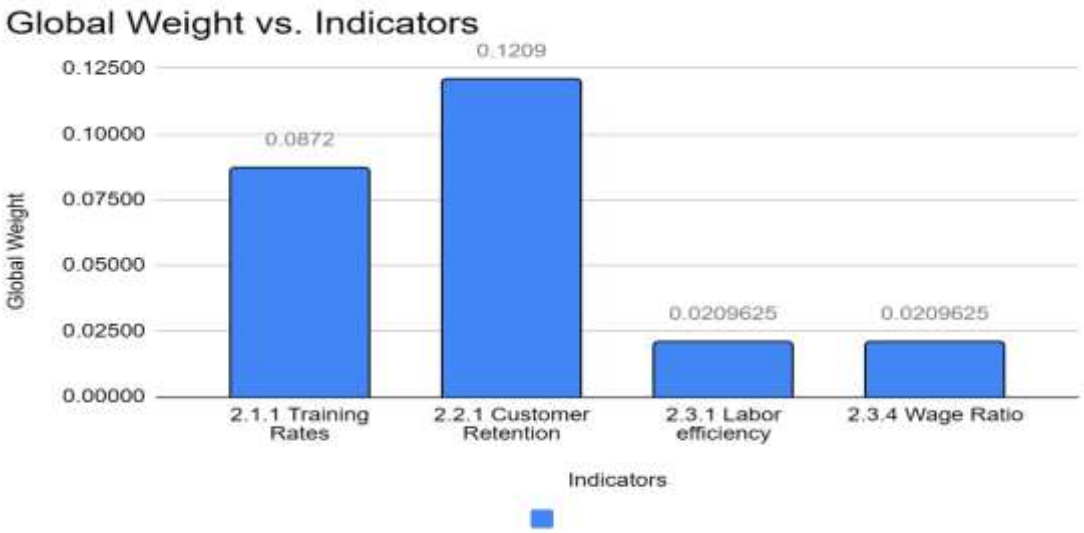

Figure 3 Global Weight for Social Factors

The consistency of the weights and ratings shall be assessed by taking the primary "eigenvectors" of each matrix and calculating the consistency index (CI) and the consistency ratio (CR). The consistency measurement is useful for identifying possible errors in judgments and actual inconsistencies in the decisions themselves. The result of inconsistency was 0.0000

4. CONCLUSIONS

Based on the overall results of data processing and analysis of assessments carried out on the performance of using the Analytic Hierarchy Process (AHP) method, the main points or conclusions can be drawn from the results of the research as follows: 1). From economic and social aspect consideration, the weight of economic is 0.75 and social is 0.25 respectively. 2). The results of the consistency level test based on the results of respondents' answers to the assessment of all criteria and sub-criteria in the selection using the Analytic Hierarchy Process (AHP) method are declared valid and consistent. This result can be seen from the achievement of the Consistency Ratio (CR) value for each calculation at the criteria, sub-criteria and alternatives levels that are still within the tolerance threshold, which is below 10% or

0.1. The achievement of the Consistency Ratio (CR) value which reaches a number below 10% or 0.1 is a reference that all answers given by respondents in the questionnaire distributed can be accepted and declared consistent and feasible to continue into the process of calculating the Analytic Hierarchy Process method (AHP). The five highest weights are logistic cost followed by customer retention and training rates for social dimension, and then capacity utilization, perceived value of product respectively.

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