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Selection of Flour Suppliers as the Main Ingredient of Onion Crackers Using the Interpretive Structural Modeling Method and Simple Multi-Attribute Rating Technique

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ABSTRACT

Raw materials are very important because raw materials are something that will determine whether the products produced are good and by the wishes of consumers or not, so it is necessary to pay attention to the provider of raw materials, namely the supplier of raw materials. The purpose of this research is to be able to find out the best suppliers by relying on the criteria that are the key criteria. In this study, the Interpretive Structural Modeling (ISM) and Simple Multi-Attribute Rating Technique (SMART) methods were used. The ISM method is useful for sorting out the criteria used so that it is obtained only in the form of key criteria while the SMART method is useful for determining the best supplier based on the existing key criteria. The results of this study are obtained from 9 key criteria out of 12 criteria used, namely quality criteria, delivery of goods, price of goods, communication system, control in operation, service improvement, attitude, packaging ability, and geographical location. The supplier that has the highest criteria based on the key criteria used is Sinar Terang supplier with a score of 0.5895 followed by Cece (0.555), Av (0.555), Aroma (0.5305), Harapan (0.5155), and finally Laris (0.4005).

Introduction

Fierce competition to get consumers in the trading business makes entrepreneurs have to find ways to be able to produce the best products that can be in demand and by the wishes of the community. The success of being able to attract public interest is inseparable from various factors such as marketing strategies, packaging, product quality, and so on. This is the key to the success of a business in marketing its products. No wonder many trade entrepreneurs pay great attention to all aspects related to products, one of which is related to raw materials.

Raw materials are important because raw materials are something that determine whether the products produced are good and by consumer desires or not. The quality of the products produced certainly also affects product sales. This is the reason why raw

materials are very important because they are one of the determinants of the company's sustainability so it is known that the supply chain system is one of the things that affects the future of the company (Hilary & Wibowo, 2021).

The supply chain can be interpreted as a process or activity carried out to obtain raw materials from suppliers which is followed by the process of adding functions and values to raw materials so that they turn into semi-finished materials or finished goods. This indicates that the selection of the supply chain is the first step in determining the success of a product after it is produced. Of course, many criteria need to be considered in the selection of the supply chain, such as the quality of the materials supplied. Choosing the right supplier or supplier who has good quality materials will produce good quality products and vice versa. (Yusuf & Soediantono, 2022).

In addition to the quality of raw materials, another thing that needs to be considered in choosing a raw material supplier is the price of raw materials. Price is one of the things that must be considered well because the price will affect several aspects such as sales activities and profits that will be achieved by entrepreneurs. (Nasution, 2019). In general, the quality of a product will be directly proportional to the price offered, just as good quality of raw materials will make the raw materials expensive. A good distribution system is the distribution of goods to the destination in good condition and the absence of quality changes during the distribution process. This proves that location is also important in determining suppliers. The remote location of raw material purchases will also affect the production time. Some of these obstacles often occur in companies when determining the supplier to be chosen. (Alfianti et al., 2021). The method that can be used to get the best supplier choice is the Interpretive Structural Modeling (ISM) method, which is processed by the Simple Multi-Attribute Rating Technique (SMART) method.

The Interpretive Structural Modeling (ISM) method is a method or a modeling technique that is useful for providing specific opinions on the criteria contained in an analyzed system. This method can prove the relationship between each criterion contained in the system and also select criteria that play an important role in the system so that it can form a good policy. The use of the ISM method makes it easier to analyze a problem that has many existing criteria. The final result of this ISM method is the grouping of existing criteria according to the value of the driven power and the level that has been obtained so that it can be converted into the final model of the ISM method, namely the conical matrix. (Rifaldi et al., 2021).

The results of the ISM method are in the form of key elements or criteria that are useful as a reference in selecting suppliers. In the selection of suppliers, the Simple Multi-Attribute Rating Technique (SMART) method is used which is a method used to be able to make a decision that has more than one criterion and each criterion has a value and weight to the existing decision. The existing criteria will make it doubtful to choose the right decision because the choice of the existing decision does not always have the entirety of the criteria needed. In simple terms, the SMART method works by analyzing the responses from voters, responding to and also making decisions on the responses

given by the decision voters. This method is often used because of its simple use and also has results that are considered quite good (Amalia & Ary, 2021).

Method

Design, place, and time

The research was conducted on Jalan Sekolah, gg. Cork, Rumbai is at the production location of the 'Chilo' onion cracker trading business. The research starts from the beginning of February to April, which includes observation of the place and the collection of data necessary for the research to be carried out.

Types and methods of data collection (survey)/research stages (laboratory)

The data collection stage is carried out by distributing two types of questionnaires, namely ISM and SMART questionnaires. The SMART questionnaire is given after obtaining the results from the ISM method because the SMART questionnaire contains the key criteria obtained from the ISM method. The number of respondents used in this study was one person, namely the owner of the onion cracker trading business 'Chilo'. This is because the requirements of the respondents used are parties who have full knowledge of all aspects in the case study used, namely onion crackers 'Chilo' so that the most appropriate respondents are the voters of the business. Other data is obtained only through interviews with business owners.

Data processing and analysis

Data processing begins by changing the questionnaire data that has been collected into a table also called the Structural Self-Interaction Matrix (SSIM) so that it will make it easier to process the next data. The stage continues with the change of SSIM data into data that only consists of numbers with values of 1 and 0 (binary numbers). The changed data is continued by conducting a transparency test to determine the relationship between the criteria and other criteria in a wider scope. The process continued by analyzing the data from the results of the transitivity test to find out the quadrant of each criterion where the position of the criterion determines whether the criterion is a key criterion or rejected. The final stage is the creation of criteria levels and the final model of ISM in the form of a display of criteria arranged according to the level.

The results of the ISM method in the form of key criteria will be continued in the SMART method where the initial process is to weight and normalize each of the existing key criteria. The next stage is to take into account the utility value of each supplier based on all criteria where the data used is from the results of the SMART method questionnaire. The results of the utility value of each criterion will be multiplied by the normalization value that has been obtained previously so that the final result is in the form of a score owned by each supplier.

Results and Discussion

ISM Method

The ISM method is used to sort out the criteria used so that it will produce key criteria. In this study, the criteria used amounted to 12 out of 23 Dickson criteria used.

Data Collection

In this study, the data used at the beginning of the processing process is the data from the ISM questionnaire. The ISM questionnaire contains statements related to the comparison between each criterion used. There are a total of 66 statements in the questionnaire.

Table 1
Structural Self-Interaction Matriks (SSIM)

	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12
K1		A	V	V	X	O	A	A	O	V	A	A
K2			V	O	O	A	A	X	O	V	O	A
K3				O	O	A	A	A	A	V	A	O
K4					O	A	O	O	A	V	A	O
K5						O	A	O	O	V	X	A
K6							V	X	X	V	O	O
K7								X	O	V	V	A
K8									X	V	V	O
K9										X	O	O
K10											A	O
K11												O
K12												

In Table 1, it can be seen that the results of the questionnaire have been changed to a table where the comparison criteria are in the row (horizontal) while the comparison criteria are in the column (vertical). The symbols used in Table 1 are VAXO symbols, each of which represents the following:

(1) Symbol V, a symbol used to indicate that the criteria in row i affect the criteria in column j but the criteria in column j do not affect the criteria in row i. (2) Symbol A, a symbol used to indicate that the criteria in row i does not affect the criteria in column j but criterion j affects the criteria in column i. (3) The symbol X, A symbol used to indicate that criterion I and criterion j both affect each other. (4) The O symbol, a symbol used to indicate that criteria i and j do not affect each other (Munawir et al., 2022).

Initial Reachability Matriks

At this stage, the SSIM data that has previously been obtained will be changed to binary numbers, namely values 1 and 0. This change intends to be able to find out the comparison of which criteria affect other criteria and vice versa, which criteria do not affect other criteria. The results of the initial reachability of this matrix also help to be able to find out the value of the driver power and dependence later.

Table 2
Initial Reachability Matriks

I/j	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12
K1	1	0	1	1	1	0	0	0	0	1	0	0
K2	1	1	1	0	0	0	0	1	0	1	0	0
K3	0	0	1	0	0	0	0	0	0	1	0	0
K4	0	0	0	1	0	0	0	0	0	1	0	0
K5	1	0	0	0	1	0	0	0	0	1	1	0

K6	0	1	1	1	0	1	1	1	1	1	0	0
K7	1	1	1	0	1	0	1	1	0	1	1	0
K8	1	1	1	0	0	1	1	1	1	1	1	0
K9	0	0	1	1	0	1	0	1	1	1	0	0
K10	0	0	0	0	0	0	0	0	1	1	0	0
K11	1	0	1	1	1	0	0	0	0	1	1	0
K12	1	1	0	0	1	0	1	0	0	0	0	1

In Table 2, it can be seen that all cells contain values consisting of values of 1 and 0. The rules for changes contained in the initial reachability matrix are as follows:

(1) V symbol, if the symbol in the cell is the V symbol, then the rule is that the value 1 will be filled in the row and the column will be filled with 0. (2) Symbol A, if the symbol in the cell is symbol A, then the rule is that the value 0 will be filled in the row section and the value 1 will be filled in the column section. (3) X symbol, if the symbol in the cell is the X symbol, then the rule is that the value 1 will be filled in the row section and the value 1 will be filled in the column section. (4)

O symbol, if the symbol in the cell is the O symbol, then the rule is that the value 0 will be filled in the row and the column will be filled with 0 (Oktavia et al., 2019), (Yurianto, 2022).

Trans visibility Testing

Transvivity testing is carried out to determine the relationship between criteria and other criteria, for example, criterion A is related to criterion B, criterion B is related to criterion C, and then indirectly criterion A is related to criterion C. (Munawir et al., 2022), (Oktavia et al., 2019). The test was carried out on all cells that had a value of 0 only.

Table 3
Transvivity Test

I/J	**K1**	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**
K1	1	0	1	1	1	0	0	0	1	1	1	0
K2	1	1	1	1	1	1	1	1	1	1	1	0
K3	0	0	1	0	0	0	0	0	1	1	0	0
K4	0	0	0	1	0	0	0	0	1	1	0	0
K5	1	0	1	1	1	0	0	0	1	1	1	0
K6	1	1	1	1	1	1	1	1	1	1	1	0
I J	**K1**	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**
K7	1	1	1	1	1	1	1	1	1	1	1	0
K8	1	1	1	1	1	1	1	1	1	1	1	0
K9	1	1	1	1	0	1	1	1	1	1	1	0
K10	0	0	1	1	0	1	0	1	1	1	0	0
K11	1	0	1	1	1	0	0	0	1	1	1	0
K12	1	1	1	1	1	0	1	1	0	1	1	1

As can be seen in Table 3, 35 pairs of criteria can be tested for transitivity so that it can be stated that the 35 pairs have a relationship.

Matriks of Crossed Impact Multiplication Applied to a Classification (MICMAC)

The results of the translucency test will be continued at the stage of making the Matrix of Crossed Impact Multiplication Applied to a Classification (MICMAC). The creation of the MICMAC model will make it easier to know which criteria can be used as key criteria. At this stage, driver power and dependence values are needed from each existing criterion. The driver power value is a value that determines the degree of influence of one criterion on other criteria, while dependence determines the degree of dependence of a criterion on other criteria. Here are the driver power and dependency values of each criterion:

Table 4
Driver *Power* Values and *Dependence* Criteria

Criterion (K)	*Driver Power*	*Dependence*
K1	7	9
K2	11	6
K3	3	11
K4	3	11
K5	7	8
K6	11	6
K7	11	6
K8	11	7
K9	10	11
K10	6	12
K11	7	9
K12	10	1

The driver power value is obtained from the sum of the total results of the translucency test in the rows of each criterion and the dependence is obtained from the sum of the total results in the columns of each criterion. (Barus & Syahbudi, 2019). These values are used to create MICMAC where coordinates are used according to the driver power and dependence values,

Figure 1 Micmac Model

In Figure 1, it can be seen that there are 4 quadrants, namely autonomous, dependent, independent, and linkage. The information from the four quadrants is as follows:

(1) Autonomous quadrant, this quadrant characterizes criteria that have weak driver power and dependency values. (2) Dependent Quadrant, this quadrant characterizes criteria that have weak driver power values and high dependence. (3) Independent Quadrant, this quadrant characterizes criteria that have a high driver power value and weak dependence. (4) Linkage quadrant, this quadrant characterizes criteria that have high driver power and dependency values (Barus & Syahbudi, 2019).

The criteria that can be used as key criteria are those in the independent quadrant and linkage because the criteria in the quadrant have a high driver power value, which means that these criteria are very influential. It can be seen that 9 criteria can be used as key criteria, namely quality criteria, delivery of goods, price of goods, communication system, control in operation, service improvement, attitude, and geographical location. In the case of the 10th criterion, the impression criterion, the reason the criterion is not used as a key criterion is because the criterion does not have enough driver power values to cross the boundary line between the dependent quadrant and the linkage so the criterion is rejected.

Level Partitionary

This partition level process is the process of determining the level of each criterion so that it is known which criteria are the most dominant according to the level.

Table 5
Level Partitionary

Criterion	*Reachability Set*	*Antecedent Set*	*Intersection Set*	*Level*
K1	1, 3, 4, 5, 9, 10, 11	1, 2, 5, 6, 7, 8, 9, 11, 12	1, 5, 9, 11	III
K2	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	2, 6, 7, 8, 9, 12	2, 6, 7, 8, 9	VII
K3	3, 9, 10	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12	3, 9, 10	I
K4	4, 9, 10	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12	4, 9, 10	I
K5	1, 3, 4, 5, 9, 10, 11	1, 2, 5, 6, 7, 8, 11, 12	1, 5, 11	IV
K6	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	2, 6, 7, 8, 9, 10	2, 6, 7, 8, 9, 10	VII
K7	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	2, 6, 7, 8, 9, 12	2, 6, 7, 8, 9	VII
K8	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	2, 6, 7, 8, 9, 10, 12	2, 6, 7, 8, 9, 10	WE
K9	1, 2, 3, 4, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 6, 7, 8, 9, 10, 11	V

K10	3, 4, 6, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	3, 4, 6, 8, 9, 10	II
K11	1, 3, 4, 5, 9, 10, 11	1, 2, 5, 6, 7, 8, 9, 11, 12	1, 5, 9, 11	III
K12	1, 2, 3, 4, 5, 7, 8, 10, 11, 12	12	12	VIII

The determination of the level in Table 5 of Level 1 is by paying attention to the reachability value of the lowest set and the antecedent value of the highest set. The reachability set is the same as the power driver value and so is the antecedent set the same as the dependency value while the intersection set is the cross of the two sets.

ISM Final Model

The results of the partitionary level are then modeled which will later become the final model of ISM. Here is a model from ISM, namely:

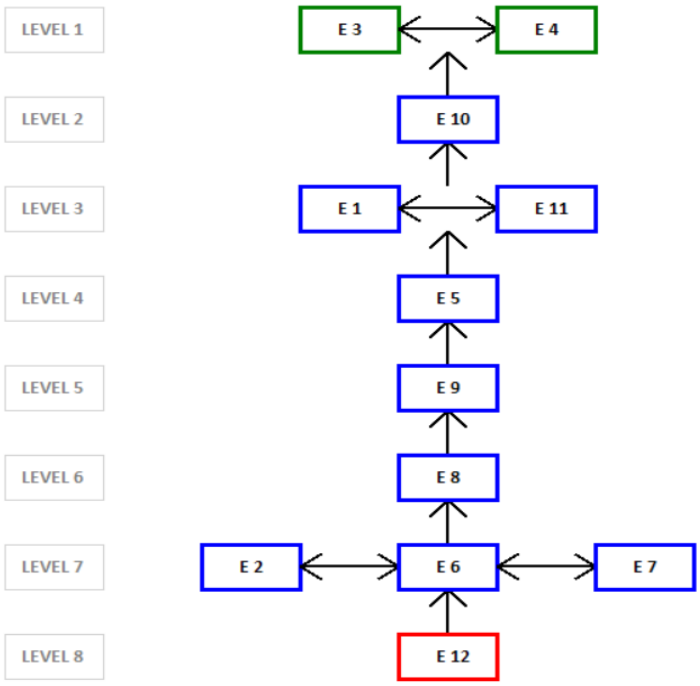

Figure 2 Final Model of ISM

SMART Method

The SMART method is used to obtain the final results and ranking of each supplier that will be tested based on the key criteria that have been obtained.

Weighting and Normalization of Key Criteria

The criteria used in this method will be weighted and normalized to determine the level of influence of each criterion on the selection of suppliers based on the business owner's point of view.

Table 6
Weight and Normalization Criteria

Criterion	Weight	Normalization
Quality	15	0,15

Shipping of Goods	15	0,15
Price	15	0,15
Communication System	5	0,05
Criterion	**Weight**	**Normalization**
Controls in operation	15	0,15
Service Improvement	10	0,1
Attitude	8	0,08
Packaging Capabilities	10	0,1
Geographical Location	7	0,07
Total	**100**	**1**

Alternative Assessment

Alternative assessments were obtained from the results of the SMART method questionnaire given to trading business owners as respondents. In the questionnaire, owners are asked to be able to give a score from 1 to 5 to each supplier based on the key criteria that exist [11].

Table 7
Alternative Assessment Criteria

Supplier	**Value**								
	Quality (K1)	**Freight Forwarding (K2)**	**Price of Goods (K3)**	**Communication System (K4)**	**Control in operation (K5)**	**Service Improvement (K6)**	**Attitude (K7)**	**Packaging Capability (K8)**	**Geographic Location (K9)**
Bestselling	4	4	4	4	2	4	3	3	4
Aroma	4	4	4	4	4	3	5	3	3
Of	5	3	5	2	4	3	3	5	3
Sinar Terang	5	4	3	3	3	3	4	5	4
Hope	4	3	4	3	4	4	4	5	3
Cece	5	3	2	4	3	4	5	4	2
Min	4	3	2	2	2	3	3	3	2
Max	5	4	5	4	4	4	5	5	4

Utility Value Calculation

The calculation of utility value is carried out to be able to find out the level of satisfaction received by business owners for each supplier based on the key criteria that exist. (Dhamija et al., 2020), (Dul Hapid et al., 2020). The calculation of the utility value using the formula is as follows:

$$\mathrm{ui(ai)} = \frac{\mathrm{Cout-Cmin}}{\mathrm{Cmax-Cmin}} \qquad (1)$$

Information:

UI (ai) = Value of the ith criterion

Cmax = Maximum Value of the i-th Criterion
Cmin = Minimum value in criterion i
Cout = Alternative Value of the ith Criterion

Table 8
Utility Value Calculation

Supplier	Value								
	Quality (K1)	**Freight Forwarding (K2)**	**Price of Goods (K3)**	**Communication System (K4)**	**Control in operation (K5)**	**Service Improvement (K6)**	**Attitude (K7)**	**Delivery Ability (K8)**	**Geographic Location (K8)**
Bestselling	0	1	0,67	1	0	1	0	0	1
Aroma	0	1	0,67	1	1	0	1	0	0,5
Of	1	0	1	0	1	0	0	1	0,5
Sinar Terang	1	1	0,33	0,5	0,5	0	0,5	1	1
Hope	0	0	0,67	0,5	1	1	0,5	1	0,5
Cece	1	0	0	1	0,5	1	1	1	0

Final Score Calculation

The final value is obtained from the product between the normalization value of the weight and the utility value of the criteria. (Hidayat & Diartono, 2024). The formula for calculating the final value is as follows:

$$u(ai) = \sum_{j=1}^{m} Wi.\,Ui.\,(ai) \qquad (2)$$

Information:
u(ai) = Total Value of the ith Alternative
Wj = Normalization Value of Criterion i
Uj(Aj) = Utility Value of the ith Criterion

Table 9
Final Score Results

Criterion	**Weight Normalization Value**	***Supplier***					
		Bestselling	**Aroma**	**Of**	**Sinar Terang**	**Hope**	**Cece**
Quality	0,15	0	0	0,15	0,15	0	0,15
Controls in operation	0,15	0,15	0,15	0	0,15	0	0
Shipping of Goods	0,15	0,1005	0,1005	0,15	0,0495	0,1005	0

Communication System	0,05	0,05	0,05	0	0,025	0,025	0,05
Controls in operation	0,15	0	0,15	0,15	0,075	0,15	0,075
Service Improvement	0,1	0,1	0	0	0	0,1	0,1
Attitude	0,08	0	0,08	0	0,04	0,04	0,08
Delivery Capability	0,1	0	0	0,1	0,1	0,1	0,1
Geographical Location	0,07	0,07	0,035	0,035	0,07	0,035	0
Final Score		**0,4005**	**0,5305**	**0,55**	**0,5895**	**0,5155**	**0,555**
Ranking		**6**	**4**	**3**	**1**	**5**	**2**

The results in Table 9 show that the supplier with the highest final score is the bright light supplier with a score of 0.5895 which shows that the supplier has an advantage in all key criteria compared to other suppliers.

Conclusion

Based on the research that has been conducted, there are 9 out of 12 criteria that are the key to determining the best supplier in supplying the main raw materials for the 'Chilo' onion cracker business, including quality, delivery of goods, price of goods, communication system, control in operation, service improvement, attitude, packaging ability, and geographical location. All the key criteria obtained were used in determining the best supplier and it was found that Sinar Terang's supplier was the most superior compared to other suppliers with an accuracy value of 0.5895. The ranking was followed by supplier Cece with a score of 0.555, Av with a score of 0.55, Aroma with a score of 0.5305, Harapan with a score of 0.5155, and the last order was Laris with a score of 0.4005.

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