Dynamic Criteria Decision-Making Model for Business Development Recommendations Using Macbeth and Surrogate Weighting Procedures

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Received: 16.04.2024 Revised : 14.05.2024 Accepted: 24.05.2024

ABSTRACT
Recommendations in business development are important for entrepreneurs in allocating resources in determining the appropriate type of business. In carrying out business development, a decision-making model is needed for entrepreneurs to produce decision recommendations regarding the type of business that has prospects for sustainability. In determining a decision with various criteria and alternatives can apply the Multi Criteria Decision Making (MCDM) decision-making technique. The complexity in multi-criteria and multi-alternative decision making can be solved by the application of MCDM, this is due to the alternative selection process based on the number of interrelated quantitative and qualitative criteria and the calculation of weight values objectively. The combination of Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH) and Surrogate Weighting Procedures technique is applied in forming a business type decision model. MACBETH method is used to perform scoring or ranking, as well as determining the final value based on the nature of qualitative and quantitative criteria. Surrogate Weighting Procedures technique that aims to determine the preference value of decision makers based on the priority order of the criteria, so as to determine the appropriate weight according to the number of criteria available. The result of this research is to determine the best alternative based on 3 quantitative criteria and 2 quantitative criteria dynamically, the criteria scoring process is successful, and the final alternative ranking process can be used as a recommendation in business development.

Keywords: Multi Criteria Analysis Model, Dynamic Criteria, MACBETH Method, Surrogate Weighting Procedures

INTRODUCTION

Developing a business is something that entrepreneurs must do to advance their business. The development of small businesses as the basis of the people's economy is one of the strategic steps that need to be followed up with real action. In the current era of digitalization, entrepreneurs are expected to understand and apply information technology to the business they are running. The existence of technology can provide convenience in conducting promotions, building relationships with consumers, and knowing the latest information that can be an opportunity for business development. In addition, technology can also be developed into a system that can help entrepreneurs in developing a business.
The impact of the pandemic has affected Indonesia's economic sector. According to an Asian Development Bank survey on the impact of the pandemic on MSMEs in Indonesia, 88% of micro businesses have run out of cash or savings, and more than 60% of these micro and small businesses have reduced their workforce[1], [2]. After experiencing a difficult time in the economy during the pandemic, Indonesia began to make changes by creating a New Normal Era business development strategy. One of the

strategies used is the Blue Ocean strategy or the strategy of creating new markets[3],[4]. The importance of implementing Blue Ocean is the creation of a strategy that companies can implement to be able to continue to grow, and make competition no longer relevant [5].

This strategy can be an alternative for entrepreneurs to carry out business development. In carrying out business development, a decision-making model is needed for entrepreneurs to produce recommendations regarding the type of business that has prospects for sustainability[6]. In the decision-making process, there are considerations of various criteria and conflicting alternatives so that the decision model can assist entrepreneurs in producing the best alternative decision on the type of business. In the urgency of research, there are several criteria, namely business capital, profit, promotion, competitors by considering several alternative types of business. In determining a decision with various criteria and alternatives can apply the Multi Criteria Decision Making (MCDM) decision-making technique[7], [8]. The complexity in multi-criteria and multi-alternative decision making can be solved by the application of MCDM, this is due to the alternative selection process based on the number of interrelated quantitative and qualitative criteria and the calculation of objective weight values [9]–[11]. Decision-making models with dynamic criteria can provide convenience for decision makers by choosing specific methods in the process of calculating quantitative and qualitative criteria and alternative selection.

Research contributions focus on forming a decision-making model by applying MCDM decision-making techniques, selecting methods considering the number of qualitative and quantitative criteria and alternatives, and determining the preference value of each criterion. In taking into account the objective value of criteria preferences, there is a Surrogate Weighting Procedures technique that aims to determine the preference value of decision makers based on the priority order of the criteria, so as to determine the appropriate weight according to the number of criteria available[12]. This technique can facilitate decision makers without subjectively calculating the weight value of the criteria. Furthermore, to determine the final results of alternative selection and ranking, the MACBETH method is used to perform scoring or ranking, as well as determining the final value based on the nature of qualitative and quantitative criteria. The Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH) method is used to convert qualitative attributes into quantitative attributes and then rank alternatives[13]. In addition, the MACBETH method has the advantage that in determining the weight of criteria and alternative assessments can be done only with qualitative assessments[14].

The implication of the research is not only to form a decision model, but to combine the MACBETH method and the Surrogate Weighting Procedures technique in completing the calculation of quantitative and qualitative criteria and determining the weight of the criteria based on the priority level of the criteria. The results of business development recommendations using the MACBETH method and Surrogate Weighting Procedures so that this system can help business owners in making decisions to choose the type of business to be developed and help the younger generation become a creative and innovative generation in entrepreneurship.

LITERATURE REVIEW

The development of Dynamic Criteria Decision Making Models for business development recommendations requires a solid understanding of Multi-Criteria Decision Making (MCDM) frameworks, especially those that incorporate dynamic elements and surrogate weighting procedures. The MACBETH method emerges as a prominent approach in this context, which facilitates a qualitative criteria assessment scoring process to measure the relative attractiveness of alternatives based on multiple criteria.

MACBETH is particularly advantageous in scenarios where decision makers face complex choices involving conflicting quantitative and qualitative criteria. The method allows structuring of decision problems and generation of value scores through qualitative assessments, which are then converted into numerical values using mathematical techniques[15]–[17]. The intricacies of qualitative judgement in the presence of quantitative data have been effectively addressed by this method in a variety of domains[13], [18], [19]. Moreover, MACBETH's flexibility in accommodating dynamic criteria makes it suitable for the ever-evolving business landscape, where decision parameters may change over time [20], [21].

Incorporating surrogate weighting procedures enhances the MACBETH framework by addressing the challenges associated with preference strength in MCDM. Surrogate weighting can help mitigate the limitations of traditional weighting methods, which often rely on static, ordinal rankings that may not capture the nuances of decision makers' preferences[22], [23]. The integration of surrogate weights allows for a more nuanced evaluation of alternatives, accommodating the dynamic nature of the business environment where criteria may change in importance over time [24], [25]. This adaptability is critical to developing recommendations that remain relevant as market conditions evolve.

Moreover, the dynamic aspect of decision making is further emphasized by the need to consider the temporal performance of alternatives, as highlighted in the literature on Dynamic Multi-Criteria Decision Making (DMCDM)[26]. This approach recognizes that the effectiveness of alternatives may vary over time, requiring models that can adapt to these changes. Therefore, the proposed dynamic multi-criteria decision-making model should integrate the MACBETH methodology and surrogate weighting techniques to provide a comprehensive framework that supports informed decision-making in the context of business development.

The synthesis of MACBETH with dynamic criteria and surrogate weighting procedures presents a robust model for business development recommendations. This integrated approach not only improves the decision-making process by accommodating both qualitative and quantitative assessments, but also ensures that the model remains relevant in the face of ever-changing business dynamics.

RESEARCH METHOD

Study Design And Setting

Macbeth Method

The Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH) Macbeth's approach solves competing criteria or attributes as well as alternative difficulties with multi-attributes by rating alternatives with different quantitative and qualitative features[27][28]. a method employing measuring scale[29][30]that can help decision-making in producing numerical preferences from qualitative and quantitative aspects. MACBETH's approach is robust in that it is a compensatory method that takes into account the positive and negative aspects of the alternatives under consideration[31], this method can solve problems where the attributes are either mutually independent or have a trade-off between attributes [32]. Decision-makers do not have to translate qualitative features into quantitative ones. The Macbeth approach consists of [14]:

1. Decision Matrix

In this process, evaluation criteria are presented in the form of a decision matrix, which is employed to obtain alternative data input information for each criterion[33].

$$X = \begin{bmatrix} r11 & \dots & r1j & \dots & r1n \\ \dots & \dots & \dots & \dots & \dots \\ ri1 & \dots & rij & \dots & rin \\ \dots & \dots & \dots & \dots & \dots \\ rm1 & \dots & rmj & \dots & rmn \end{bmatrix}_{m \times n} ; i = j, ..., m, j = 1, ..., n \quad (1)$$

Where; r_{ij} = the element of the decision matrix for ith alternative in jth attribute. In addition, the decision maker provides the weight of attribute[w1; w2; ...; wn].

2. Converting of Semantic Scale into Numerical Scale

Variations in attribute values that are contingent upon the presence of either positive or negative attributes. The negative attributes are transformed into positive attributes during the conversion of the semantic scale to a numerical scale, which is achieved by employing a seven-point semantic scale[34].

Table 1. Seven-Point Semantic Scale

Semantic Scale	Equivalent numerical scale (negative attribute)	Equivalent numerical scale (positive attribute)	Significance
Null	6	0	Indifference to alternatives
Very Weak	5	1	An alternative is very weakly attractive over another
Weak	4	2	An alternative is weakly attractive over another
moderate	3	3	An alternative is moderately attractive over another
Strong	2	4	An alternative is strongly attractive over another
Very Strong	1	5	An alternative is very strongly attractive over another
Extreme	0	6	An alternative is extremely attractive over another

3. Preference Level

The alternative preference value for each attribute is determined by the alternative decision-maker. A score of 100 is assigned to the ith alternative reference value on the jth largest attribute. Conversely, the jth lowest attribute's ith alternative reference value is assigned a score of 0.

$r_j^- = \min r_{ij}$; i = 1, ..., m, j = 1, ..., n (2)

$r_j^+ = \max r_{ij}$; i=1, ..., m, j=1, ..., n (3)

where

r_j^- =the smallest reference values

r_j^+ = the largest reference values

4. Macbeth Score (V)

This phase involves the arrangement of alternatives and criteria in a pairwise evaluation matrix in order of their significance, from left to right.

$$v(r_{ij}) = v(r_j^-) + \frac{(r_{ij} - r_j^-)}{(r_j^+ - r_j^-)}\left[v(r_j^+) - v(r_j^-)\right]; = \quad i=1, ...,m,$$

j=1, ...,n (4)

where

$v(r_{ij})$ = macbeth score on ith alternative in jth attribute

5. Calculation of Final Ranking Score

This phase involves the evaluation of decision makers, which is achieved through pairwise comparisons into the MACBETH scale by solving the linear programming model.

$V_i = \sum_{j=1}^{n} v(r_{ij}).w_j$; i=1, ...,m (5)

where

V_i = final score of ith alternative

$v(r_{ij})$ = macbeth score on ith alternative in jth attribute

w_j = jth attribute weight value

6. Final Ranking Calculation

The weight and criteria equation is employed to determine the alternative's overall score in the final stage.

$V_i > \ldots\ldots > V_m$; i=1, ...,m (6)

Surrogate Weighting Procedures

Surrogate Weighting Procedures is a technique used to determine the weight value only based on the priority order of the criteria from the most prioritized or seeing the same degree of importance in each criterion[35]. There are several methods for representing priorities and translating information about weight rankings into specific values for each criterion weight, so surrogate values are used for decision making[36], [37]. The simplest method is to determine equal weight or known as Equal Weight (EW). The assumption of this method is that all elements are of equal significance to the decision problem and that there is no prioritisation information among criteria. Rank Sum (RS) is a method that normalises the relationship between the rank position of the criteria and the sum of the ranks in order to assign weights. The range of weights is normalised by a scale that defines the priority of the criteria as n (number of rankings), using the number of criteria. The method of Rank Order Centroid (ROC) is concerned with the priority level of the criteria and the weighting of each criterion based on its priority ranking [38]. This research uses the ROC technique in calculating the objective criterion preference value by determining the priority level of each criterion starting from the priority of the 1st criterion, the priority of the 2nd criterion to the priority of the nth criterion.

$$W_j = \frac{1}{K}\sum_{i=j}^{K}\left(\frac{1}{i}\right) \quad (7)$$

Where:

Wj = kth attribute weighting value

K = number of attributes

i = attribute priority order value

Study Population

The population in this study were small entrepreneurs in various fields in the Bali area. From this population, there are 150 research respondents consisting of small and medium entrepreneurs from handicraft businesses, F & B businesses and other businesses. based on the research respondents, then provide questions related to criteria data in determining the type of business and alternatives to the type of business.

Data Collection

In determining the Decision-Making Model for Business Development Recommendations, there are criteria data obtained from 150 respondents of small entrepreneurs in the Bali area, by applying the questionnaire technique, 5 criteria (C) were selected in determining the type of business, namely profit (C1), capital (C2), promotion (C3), competitors (C4) and business prospects (C5). There are 5 alternatives (A), namely the Cake Shop business type (A1), Florist business type (A2), Cake Material Shop business type (A3), Electronics Shop business type (A3) and Stationery Shop business type (A4).

RESULT AND DISCUSSION

Criteria and AlternativeAnalysis

Based on the results of data collection, then there is a determination of the type of criteria based on the type of data, namely quantitative data and qualitative data. For each criterion, the nature of the criteria is determined, including benefit or cost criteria. Criteria data can be seen in table 1.

Table 2. Criteria Data Details

Criteria Code	Criteria Name	Criteria Type	Nature of Criteria
C1	Profit	Quantitative	Benefit
C2	Capital	Quantitative	Benefit
C3	Promotion	Qualitative	Benefit
C4	Competitors	Qualitative	Benefit
C5	Business Prospect	Qualitative	Cost

Based on the criteria data table above, there are types of quantitative and qualitative criteria based on the type of criteria data. Quantitative criteria, consisting of Capital (C2), are said to be quantitative criteria because they refer to data in the form of numbers, and can be measured the amount of capital needed in a business. Profit criteria (C1) are said to be quantitative criteria because in addition to producing data in the form of numbers carried out using mathematical calculation techniques, profit is also objective, which means that it can be interpreted by everyone regarding the amount of profit that will be obtained each month. Qualitative criteria, consisting of business prospects (C5), are said to be qualitative criteria because business prospects are a general description of a business in the future based on potential and supporting factors, so these criteria can only be observed and are non-numerical. Promotion criteria (C3) are said to be qualitative criteria because promotion is an effort to inform or offer a product to potential customers, so these criteria can only be described through the form of persuasive sentences. Competitor Criteria (C4) are said to be qualitative criteria because competitors are other forms of business that have similar business products to the business currently being run or the business to be run, so these criteria can only be observed in the form of non-numeric data.

Each criterion is categorized into benefit and cost criteria. The difference between benefit and cost criteria is that benefit criteria are criteria that the higher the weight value, the better the value, while cost criteria are criteria that the greater the weight value, the lower the value. In this research, benefit criteria are denoted by a (+) symbol while cost criteria are denoted by a (-) symbol.

Application of the MACBETH Method

A. Decision Matrix

The conversion of qualitative attributes to numerical values is a process. Quantitative attributes are not converted. The attribute's influence is more significant when the positive attribute properties are better determined, and the influence is more significant when the negative attribute properties are better determined. The smaller the attribute value, the greater the influence.

	+ C1	+ C2	+ C3	+ C4	- C5
A1	Very Weak	15.690.000	15.000.000	Very Strong	Very Strong
A2	Moderate	25.000.000	3.000.000	Strong	Strong
A3	Moderate	53.900.000	10.880.000	Moderate	Moderate
A4	Very Strong	117.000.000	23.400.000	Very Strong	Weak
A5	Strong	15.000.000	7.500.000	Moderate	Moderate

Fig 1. Alternative Decision Matrix on each criterion

B. Weigh Attributes

Calculate the weights of the assessment attributes using the ROC technique with equation (7). Calculation of the criterion preference value (W) or criterion weight value using equation (4) so that the 1st criterion priority level is Profit, the 2nd criterion priority level is Capital, the 3rd criterion priority level is Promotion, the 2nd criterion priority level is Competitors, the 2nd criterion priority level is Business Prospects.

Table 2. Weight Attributes

Attribute	C1	C2	C3	C4	C5
W_j	0,457	0,257	0,157	0,090	0,040

C. Converting Semantic Scale into Numerical Scale

In this process, there is a change in the semantic scale to a numerical scale for qualitative criteria, namely C1, C4, and C5. This numerical scale change is adjusted to the nature of each criterion, namely benefits and costs.

Table 3. Attributes Conversion Value

Attribute	C1	C4	C5
A1	1	5	1
A2	3	4	2
A3	3	3	3
A4	5	5	4
A5	4	3	3

D. Value of reference level

The r^- value, which is the largest alternative value for each attribute, and the r^+ value, which is the smallest alternative value for each attribute, are used to determine the reference level value.

Table 4. Value of Reference Level

Attribute	C1	C2	C3	C4	C5
r^-	1	15.000.000	3.000.000	3	1
r^+	5	117.000.000	23.400.000	5	4

E. The MACBETH Score (V)

The MACBETH score is computed to ascertain the value of each alternative.

$V_1 = 0 + \frac{(1-1)}{(5-1)} \text{ x } (100 - 0) = 0$

$V_2 = 0 + \frac{(3-1)}{(5-1)} \text{ x} (100 - 0) = 50$

$V_3 = 0 + \frac{(3-1)}{(5-1)} \text{ x } (100 - 0) = 50$

$V_4 = 0 + \frac{(5-1)}{(5-1)} \text{ x } (100 - 0) = 100$

$V_5 = 0 + \frac{(4-1)}{(5-1)} \text{ x } (100 - 0) = 75$

The value of each alternative on each criterion is determined from the MACBETH score calculation. The MACBETHscore is determined by converting qualitative attribute values to numerical values. Simultaneously, the quantitative attribute values determine the ultimate classification value.

Table 5. Macbeth Score

	C1	C2	C3	C4	C5
A1	0	0,676	58,823	100	0
A2	50	9,803	0	50	33,333
A3	50	38,137	38,627	0	66,667
A4	100	100	100	100	100
A5	75	0	22,058	0	133,333

F. Calculation of Final Ranking Score

At this stage the results of the MACBETH score calculation will be summed up into an overall score to get a ranking of each alternative with a final value of V for each alternative.

Table 6. Overall Alternative Score

	C1	C2	C3	C4	C5	V
A1	0	0,676	58,823	100	0	159,499
A2	50	9,803	0	50	33,333	143,136
A3	50	38,137	38,627	0	66,667	193,431
A4	100	100	100	100	100	500
A5	75	0	22,058	0	133,333	230,391

Based on the results of the above calculations, it can be concluded that in this case study which has the highest score is an electronic store or the fourth alternative (A4). Therefore, the fourth alternative (A4) is the best alternative recommended for business development. The ranking of each alternative can be described as follows.
A4>A5>A3>A1>A2

CONCLUSION

The combination of MACBETH method and surrogate weighting procedures technique has been able to produce the best alternative in determining the type of business to be developed. The MACBETH method is used to examine alternatives with multicriteria and rank alternatives with respect to various qualitative and quantitative criteria. While the surrogate weighting procedures method is able to convert the priority level of criteria into a numerical weight value with a simple calculation but still takes into account the relationship between the priority level of criteria and the number of criteria. The methods used in this research are the MACBETH method and the surrogate weighting procedures method. The MACBETH method is used to examine alternatives with multicriteria and rank alternatives with respect to various qualitative and quantitative criteria. While the surrogate weighting procedures method is able to convert the priority level of criteria into a numerical weight value with a simple calculation but still takes into account the relationship between the priority level of criteria and the number of criteria. Suggestions for future research are the need for sensitivity analysis on each combination of methods to determine the method that is most sensitive to changes in weight values, conduct sensitivity analysis on criteria so as to find out the most critical criteria and affect changes in the final results of alternative rankings.

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