Application of Analytical Hierarchy Process (AHP) in Determining the Development Strategy of Tempeh Processed Product

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Abstract—This study aims to determine the criteria and best strategies for developing new products processed tempeh in Surakarta City. The research design used is descriptive-analytical by basing data from key informants through in-depth interviews combined with focus group discussions. The collected data is compiled, analyzed, and discussed to illustrate the reality of tempeh-processed SMEs in the field. Aggregation techniques for making conclusions from diverse information using source triangulation. While analytical tools determine strategic priorities using the analytical hierarchy process (AHP). The study results obtained six criteria for developing new products for processed tempeh. These criteria are market demand, risk of production failure, tempeh processed technology that has been mastered, waste handling, absorbing labor, and profits. In contrast, the alternative strategies that are successfully formulated based on the SWOT matrix consist of three alternative strategies: product differentiation, improving product quality and packaging, and the legality of products supported by digital marketing. Based on AHP obtained, the most important criterion is profit. In contrast, the priority strategy for developing processed tempeh products is to improve the product's quality and packaging. This study provides helpful information in solving the problem of SMEs in determining the priorities of various alternatives faced by SMEs. AHP-based analysis can overcome the weakness of SMEs who do not orderly document quantitative data because AHP can process both quantitative and qualitative data.

Keywords—AHP; Tempe; strategy; new product; Surakarta.

I. INTRODUCTION

The earliest reference to tempeh is found in Serat Centhini, a manuscript written in the 1600s and published in 1815 during the reign of King Pakubuwono V of the Surakarta Kingdom, Central Java [1]. Serat Centhini is a book that contains a collection of legends, traditions, and teachings of Javanese life at that time. Therefore, tempeh is one of the traditional foods in Indonesia; all Indonesians (low, middle, and upper incomes) like to consume tempeh. Although tempeh is cheap, the nutritional ingredient of tempeh is very good. Various studies on the nutritional value of tempeh have been widely conducted [1]. Many studies conclude that tempeh contains elements valuable to the body, namely fatty acids, minerals, vitamins, protein, and antioxidants [1],[2].

The price of tempeh is affordable to the broader community [1],[3], thus making tempeh the main side dish of Indonesians [4]. Therefore, there is a saying: "it is not perfect if there is no tempeh at the dinner table". This saying is very reasonable because the price of tempeh is low, tastes delicious, is easily digested body digesting organs, and has high nutritional content, especially types of protein [5].

Various benefits of tempeh for humans can be used to improve people's nutrition at low prices. Efforts to improve people's nutritional status are gaining momentum in light of the Global Nutrition Report in 2016; Indonesia is ranked 108th in the world with the most cases of malnutrition [3]. The sensory character of tempeh that consumers prefer less has become a severe concern for many researchers, giving rise to various studies with the theme of tempeh-making innovation [6].

Innovations still little done by researchers are developing processed product tempeh [6]. Research related to the development of processed products tempeh needs to be intensified because the orientation of processed product development is always market-oriented [7], so tempeh has an excellent opportunity to be used as a culinary tourism attraction [8],[9]. The development of processed tempeh products is a very rational choice for maximizing the profits of entrepreneurs because the market segment is already available, and thus product development has less risk than

other intensive strategies. Recommendations for developing processed tempeh products are following the expectations of the Surakarta city government, which encourages culinary business actors to diversify food products made from tempeh.

Related to the policy of the Surakarta city government that wants to increase the number of culinary tourists visiting the city of Surakarta, this study aims: to identify the criteria/factors that are a success factor in supporting the success of the tempeh industrial system and determining the formulation of the most effective strategy applied in developing the tempeh industry in the city of Surakarta.

II. MATERIALS AND METHOD

A. Research Design

The research method used in this study is descriptive-analytical, i.e., the researcher focus on the latest tempeh industry problems in Surakarta. Data was obtained through observation techniques, in-depth interviews with key informants [9],[10], and record-keeping. The collected data is compiled, analyzed, and explained the relationships between phenomena in the tempeh industry [12]. Research locations are selected purposively (Surakarta city), with a much tempeh production [13]. This research's substantial value is previous research that recommends product development.

The description of respondents is described by descriptive statistics that contain respondent profiles in the form of average values and percentages (%). The analysis is conducted to determine the priority strategies used by the AHP so that the respondents selected are not intended to represent the population but who have the best information (complete and deep). For this reason, respondents to this study were determined purposively, namely experts of elements of successful tempeh entrepreneurs, government officials related to the tempeh industry, and academics. The stages of research are depicted in Figure 1.
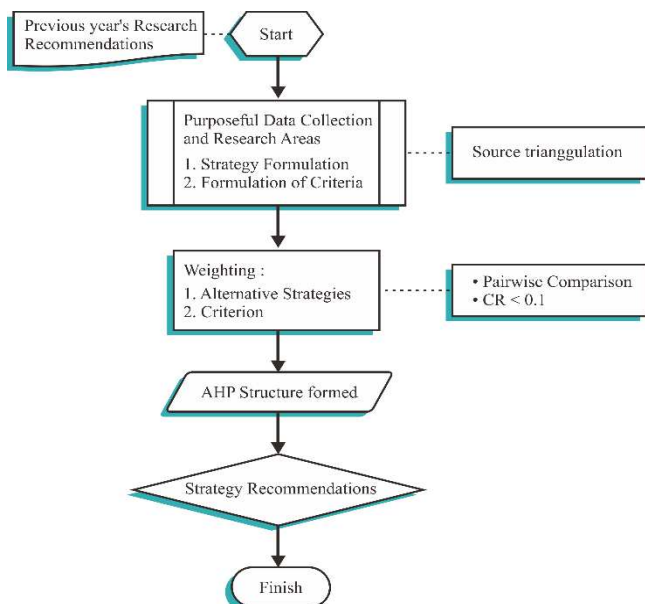

Fig. 1 Research process flowchart

B. Research Instrument

The collected data includes various criteria for developing processed tempeh and various alternative strategies implemented in developing the processed tempeh industry. Alternatives considered include market demand, risk of production errors, tempeh processing technology, labor absorption, and profitability. Meanwhile, the alternative strategies include product differentiation, product quality and packaging improvement, and the legality of products supported by digital marketing. Assessment of various criteria and an alternative strategy was carried out by pairwise comparison techniques [14].

C. Data Collection

The data collected in this study consisted of primary and secondary data. Primary data were obtained through in-depth interviews with questionnaire aids. Secondary data is obtained from several key informants (cooperatives, governments) and the internet. The source triangulation technique validated the aggregation of answer variations [11], [15]. Data triangulation refers to not only combining but also unifying various data sources. Interconnectivity between data sources ensures that various evidence sources support the findings [16],[17].
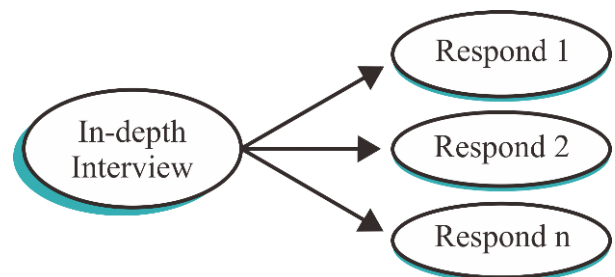

Fig. 2 Source triangulation

The triangulation process starts by obtaining information from many key Informants compared to previous informant keys. The source triangulation process can be seen in figure 2. To determine the development strategy of processed products tempeh and the criteria considered using AHP with the help of expert choice program version 11. The selection of AHP is an analytical tool because AHP can solve disorganized/complex multi-criterion problems and ensure the validity of the assessment of criteria and alternatives chosen by decision-makers [22],[23]. It is tested using a paired comparison matrix to ensure the consistency of respondents' answers [18].

The decision model in this study is built in a multilevel diagram, starting with the criteria considered in developing processed tempeh products and then alternative strategies for developing processed tempeh products. Respondents were asked to assess the importance of each criterion compared to other criteria based on the respondent's experience and area of expertise. Similarly, to determine the strategy's priorities, respondents were asked to assess each alternative strategy compared to other alternative strategies based on the respondent's understanding and expertise. Prioritization of criteria and strategy is needed so that in running their business, tempeh SMEs can focus on carrying out their business processes to have sustainable competitiveness [22].

A. Description of the Respondent's Character

The respondent's description includes aspects of the respondent's gender, age, and position. There were more male respondents (9 people or 53%), while female respondents were eight people (47%). Most respondents were 40 years old, and 94% (16 people). In addition, most respondents were owners and managers of tempeh production businesses (88%). Respondents from government and academic elements were represented by only one person (6%). The position of government and academia in this study is necessary to determine the criteria and alternative strategies.

B. Hierarchical Structure

AHP is one method to help determine the priority of various alternative options by using many criteria with its primary data input from human perception [14], [18]. The hierarchical structure of AHP in this study is built into three hierarchies [23]; That is, the first hierarchy is the goal of choosing a strategy, the second hierarchy is the criterion, and the third is the alternative strategy. The purpose of choosing the strategy in question is to determine the best strategy to develop processed tempeh products in Surakarta City.

The hierarchy of AHP in this study was compiled after the criteria and alternative strategies for developing tempeh-processed products in Surakarta City had been established. The determining factor in choosing AHP as an analytical tool in this study is the ability of AHP to accommodate many criteria together. In addition, the reliability of AHP as an analytical tool has also been accepted by decision-makers and researchers [24]. The criteria are obtained from in-depth interviews with several key informants. Respondents in this study consisted of academics, officials of the Department of Labor and Industry of Surakarta City, and successful tempeh entrepreneurs. Based on the results of in-depth interviews obtained by six criteria to develop the tempeh processing industry in Surakarta City: market demand, risk of production failure, processed tempeh technology has been mastered, waste handling, labour absorption, and profit.

The next step Is to place alternative strategies in the hierarchical structure at the third level. Alternative strategies to be compared are taken from previous research recommendations using QSPM analysis tools; Three alternative recommendations of this strategy are 1) Product differentiation, 2) Improvement of product quality and packaging, and 3) the Legality of products supported by digital marketing [13].

Hierarchies allow the division of complex or unstructured problems into the elements of the problem, then arranging them in a hierarchical framework [25]. AHP is designed to rationally capture people's perceptions (qualitative data) closely related to the problems faced through hierarchical procedures, thus generating quantitative conclusions [24], [26]. The clarity of the results of the AHP is what makes AHP a widely used analytical tool by researchers and policymakers [25], [27]. The flexibility of AHP in providing information to decision-makers is an advantage for AHP; it becomes an analytical tool that decision-makers widely use in various fields of work from various countries in the world [28],[29],[30],[31]

C. Prioritization of Criteria

Criteria-criteria considered in developing tempeh-processed products in Surakarta City were obtained from in-depth interviews in the form of assessment of respondents whose data is processed using Expert Choice *software* version 11 [31], [32]. The first stage is to calculate the priority value of each criterion from the assessment given by respondents. The best criteria can be identified by comparing the criteria set [18]. The criteria successfully identified in the research were as many as six: market demand, risk of production failure, processed tempeh technology, waste handling, absorbing labor, and profits, then analyzed with AHP. Apunthe results of data processing with the analytical hierarchy process (AHP) method obtained the following results:

TABLE I
CRITERION WEIGHT ASSESSMENT

No	Criteria	Weight	Priority
1	Market Demand	0.298	2
2	Risk of Production Failure	0.043	5
3	Tempe Processed Technology	0.115	3
4	Waste Handling	0.071	4
5	Absorbing Labor	0.029	6
6	Profit	0.444	1
	Total	1.000	

*) Inconsistency Ratio (0.09 < 0.10 = fit)

Table 1 shows the priority order of criteria for developing processed tempeh products in Surakarta City. It is as follows: profit criteria have the highest priority order with a weight value of 0.444, followed by market demand criteria (0.298), criteria for processed tempeh technology that has been mastered (0.115), waste handling criteria (0.071), risk criteria for production failure (0.043) and the last is criteria for absorbing labor (0.029).

The selection of profit criteria as the most considered criterion in developing processed tempeh products is logical because the goal of entrepreneurs to innovate is to expand market share and increase competitiveness and profitability [33],[34],[35],[36]. This is in line with [37] that the ultimate goal of the company's management to innovate product development is to increase competitiveness and profitability [38]. The analysis can be seen in Figure 3.
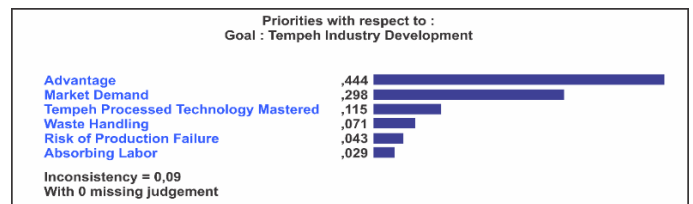

Fig. 3 Priority of each criterion

The inconsistency ratio value on the criteria considered in developing tempeh-processed products in Surakarta is 0.09. The value indicates that analytical hierarchy process (AHP) results are acceptable because the inconsistency ratio is below 0.1.

D. Prioritization of Strategy

The assessment results from AHP show that the strategy's priority for developing new processed tempeh products in Surakarta City is improving the quality and packaging of the product (weight 0,415). While the product differentiation

strategy gets a weight value of 0.405, and the last is the product legality strategy supported by digital marketing with a weight value of 0.179.

Based on the weight value, the recommendation given to developing processed tempeh products is to improve tempeh processed products in terms of quality and packaging. Quality tempeh needs to be developed because quality is the central aspect of product competitiveness [39],[7]. While the packaging element also needs to be improved because product packaging is the first attraction that interests consumers in a product. To ensure the success of product development, the research and development department must consider marketing, human resources, and financial aspects [40], [41]. The development of food products (made from tempeh) must arrive at taste testing [42]. Analysis of strategy priority selection can be seen in Table 2

TABLE II
PRIORITY STRATEGY

No	Alternative Strategies	Weight	Priority
1	Product Differentiation	0.405	2
2	Product Quality and Packaging Improvement	0.415	1
3	The legality of products supported by digital marketing	0.179	3
	Total	1.000	

*) Inconsistency Ratio (0.06 < 0.10 = fit)

Thus, based on the analysis using AHP, it was concluded that profit was the most considered criterion in developing processed tempeh products in Surakarta. At the same time, the strategy that should be prioritized is to improve the quality and packaging of products (Table 2). The value of inconsistency in determining the criteria strategy for developing processed tempeh products in Surakarta City is 0.00. The value indicates that the analytical hierarchy process (AHP) results are acceptable because the inconsistency ratio is below 0.1.

The priority of the selected criteria and strategy priorities indicate that the development of processed tempeh products is consistent with efforts to increase product competitiveness [36]. Quality improvement and product packaging are also a force in controlling the market [43] and can reduce product damage and loss [36],[43].

Thus, improving the quality and the quality of packaging can increase the competitiveness of products, which in turn will increase the profits of Tempeh SMEs [33], [34]. Based on the entire series of analyses and discussions above, the hierarchical structure of the development of processed tempeh products in Surakarta can be described in Figure 4.
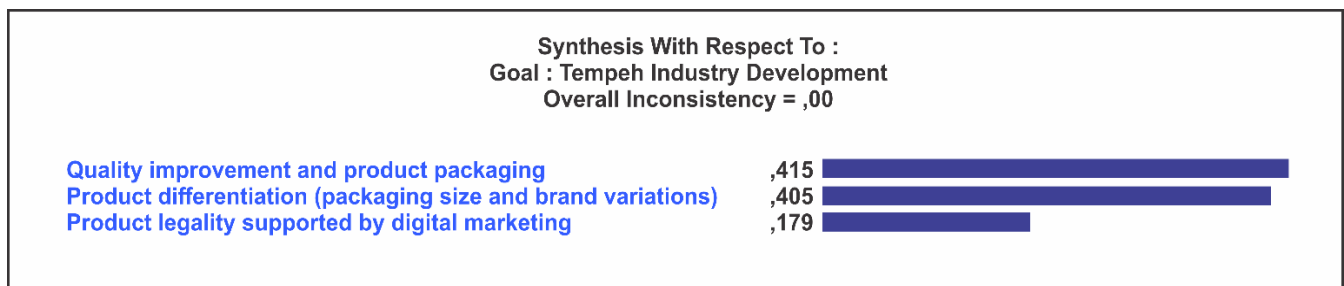

Fig. 4 Priority strategy to develop tempeh processed products

Therefore, tempeh SMEs should be encouraged to improve the quality of their product packaging [33] because improving product quality and packaging can reduce consumers' negative perception of the product as well as reduce product damage [30],[36].

Furthermore, in the entire series of analyses and discussions above, the hierarchical structure of the development of processed tempeh products in Surakarta can be described in Figure 5.
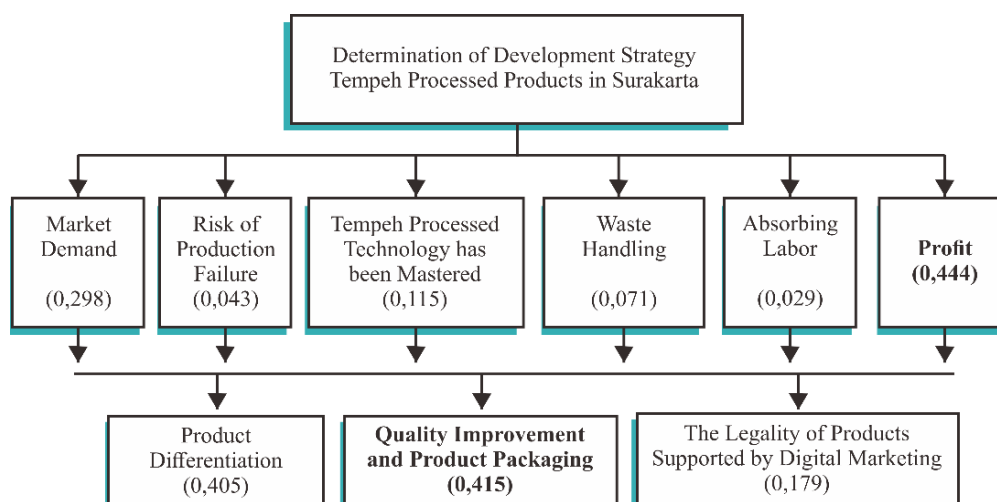

Fig. 5 Hierarchy of strategies to determine the development of processed tempeh products in Surakarta city

In improving the packaging of its products, tempeh SMEs need to consider consumer opinions and impressions of the product's durability [41]. In turn, the strategy of improving the quality and packaging of products will have an impact on increasing loyalty, improving performance, and growing profits of tempeh SMEs [41],[36],[45],[46]. These strategy recommendations align with various studies that conclude that improving product quality and packaging better than competitors will increase product competitiveness, which in turn will increase the company's profits [33],[34],[43]. Improving product quality and packaging as a strategy for winning the competition in the market does not only apply to SMEs but also to world-class companies [47]. To achieve a competitive advantage sustainably, SMEs must be able to improve product quality and packaging quality that is not easily imitated by their competitors [40],[41],[49]

IV. CONCLUSION

This study shows six criteria taken into consideration by culinary entrepreneurs of processed tempeh products in Surakarta city. The six criteria are Market Demand, Risk of production failure, tempeh processed technology that has been mastered, Waste handling, Absorbing labour, and Profits. At the same time, alternative strategies may be applied as many as three: product differentiation, quality, product packaging improvement, and legality of products supported by digital marketing. Based on the AHP method, the priority strategy for developing tempeh-processed products in Surakarta is to improve the quality of tempeh products accompanied by packaging improvements. This strategy was chosen because it is considered the most prominent result of profit. The results of this study guide culinary entrepreneurs in Surakarta that if they want to succeed in developing processed products, tempeh must pay attention to two aspects: the quality of tempeh products and the quality of packaging. This strategy can be implemented by implementing strategic quality management, a paradigm to produce tempeh-processed products that are more quality than competitors' products, and a more attractive packaging display according to the target consumer packaging of competitors' products.

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