

Developing cluster strategy of apples dodol SMEs by integration K-means clustering and analytical hierarchy process method

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Abstract. The purposes of this research were to determine the grouping of apples dodol small and medium enterprises (SMEs) in Batu City and to determine an appropriate development strategy for each cluster. The methods used for clustering SMEs was k-means. The Analytical Hierarchy Process (AHP) approach was then applied to determine the development strategy priority for each cluster. The variables used in grouping include production capacity per month, length of operation, investment value, average sales revenue per month, amount of SMEs assets, and the number of workers. Several factors were considered in AHP include industry cluster, government, as well as related and supporting industries. Data was collected using the methods of questionnaire and interviews. SMEs respondents were selected among SMEs apples dodol in Batu City using purposive sampling. The result showed that two clusters were formed from five apples dodol SMEs. The 1st cluster of apples dodol SMEs, classified as small enterprises, included SME A, SME C, and SME D. The 2nd cluster of SMEs apples dodol, classified as medium enterprises, consisted of SME B and SME E. The AHP results indicated that the priority development strategy for the 1st cluster of apples dodol SMEs was improving quality and the product standardisation, while for the 2nd cluster was increasing the marketing access.

1. Introduction

In Batu City, a high apple production, counted at 17.05 tons/ha, supports apple-processing industry to develop [1]. The apple (*Malus sylvestris*) is then processed into different products, such as apple chips made from the sub-grade apples [1]. Currently, the implementation of industrial clusters is critical due to the demands of global industry competitiveness, leading to the transformation of individual competencies into institutional clusters [2]. Apple-processing SMEs, especially apple dodol SMEs, have some problems such as poor product standardisation, limited market access, limited capital access, poor knowledge on marketing and business strategy, limited partnership with other organisations, and non-conducive business atmosphere. Recently, SMEs have been mainly characterised based on their activity, area, and business size. Such clustering method is considered as less appropriate because each group often has a different number of group members, thus special coaching technique is required [3].



To facilitate the participation of related parties/stakeholders in tackling the SMEs problems, clustering and classification processes become essential [2]. Cluster defined as a business group which consists of some businesses in an area with similar business sector [4]. Furthermore, the SMEs clustering may bring various benefits such as higher job employment, easier access to capital sources and supplier, specific service input, as well as information and knowledge transfer [3]. The development of industrial cluster is widely explained using Diamond Porter Model, which consists of four main factors and two additional factors. The main factors are (1) condition, (2) related and supporting industry, (3) strategy, structure and competition and (4) demand condition, while the additional factors are (1) opportunity and (2) government [5].

2. Materials and Methods

2.1. Problem limitation

The problem limitations of this research were as follows:

1. This research object only consisted of the registered and actively operated apple dodol SMEs, based on the data acquired from the Department of Cooperatives, SMEs, Industry and Trade (DISKOPERINDAG).
2. Apple dodol SMEs were clustered based on several characteristics include monthly production capacity, operating period, investment value, average sale per month, total asset of business unit, and total number of workers.
3. Factors used to develop the SMEs consisted of industrial cluster, government, as well as related and supporting industry.

2.2. The sampling methods

In this research, the sample population was targeted from all apple dodol SMEs in East Java. However, the population of apple dodol SMEs in Batu City was selected due to the easy access for data, information and a site visit. The purposive sampling method was employed to choose the apple dodol SMEs sample as respondents. The main selection criteria were that the SMEs still exists and operates over the last 3 years. The selected samples were consisted of five apple dodol SMEs, namely Agro Citra Abadi Industry (SME A), CV. Bagus Agriseta Mandiri (SME B), Petik Apel Farm (SME C), Barokah Jaya (SME D), and UD. Harum Manis (SME E).

Similarly, the expert respondents for analysing the strategy formulation were also selected using the purposive sampling method. Three experts were chosen include the practitioners from the SMEs Association in Batu City (i.e. Guyub Rukun Agawe Santosa/GRAS and Association of Batu City Entrepreneur/APKB) and the government (i.e. DISKOPERINDAG staff). Those experts were selected due to their competencies to guidance the apple dodol SMEs in Batu City. The data were collected using questionnaires with Likert scale (1-5) to assess the SMEs responses from Disagree to Agree.

2.3. K-means clustering methods

The classification processes was carried out using *k-means clustering* method with the following steps [6]:

1. Determining Cluster Number
2. Calculating the centroids of the K clusters
3. Calculating minimum distance among data and centroid using *Euclidean Distance*
4. Classifying data based on the minimum distance
5. Re-calculating the centroid, so that no object is moved

2.4. AHP approach

The AHP analysis was conducted using a complementary comparison scale of 1-9. The steps are as follows [7]:

1. Problem decomposition by arranging hierarchy.
2. Arranging composite opinion matrix.

3. Arranging decision element priority.
4. Calculating λ max value and Consistency Index (CI).
5. Calculating Consistency Ratio (CR)

3. Results and Discussion

The results show that, in analysing the K-means clustering data, two iterations were needed to reach the optimum values. Two clusters SMEs were identified from the process, as seen in Table 1. The table illustrates that three SMEs (i.e. SME A, SME C, and SME D) were part of the 1st cluster, while other SMEs (i.e. SME B and SME E) were in the 2nd cluster.

Table 1. The SMEs characteristics.

Characteristics	1 st cluster (SMEs A, C, and D)	2 nd cluster (SMEs B and E)
	Cluster Center	
Monthly production capacity (kg)	1,016.67	963.5
Operating period (year)	4	12.5
Investment value (IDR)	12,940,666	373,500,000
Average sale per month (IDR)	31,333,333	25,850,000
Total asset possession (IDR)	47,666,666	360,000,000
Total workers (people)	10	37

Table 1 also shows that each cluster has different characteristics. For instance, in terms of monthly production capacity, the 1st cluster was higher than the 2nd cluster. This was due to the strategy applied by the 1st cluster was solely focused on producing apple dodol, while the 2nd cluster was able to diversify various types of apple products (i.e. apple wingko, apple crisp, concentrated apple juice beverages). Furthermore, compared to the 1st cluster, the 2nd cluster SMEs was supported with their own outlet to independently market their products, either for retail or wholesaler purpose. All SMEs clusters tend to have a flexible production capacity depended on the market demand. However, a lack of capital support for all SMEs clusters has limited the production capacity. Therefore, they did not have a regular and constant production capacity. This condition made their selling price to be less competitive compared to other SMEs producing larger quantities of similar products.

A business can be maintained because of its market flexibility and competitiveness to deal with many business competitions. More experience means better skill and knowledge to analyze the probability which may occur as a consequence of the chosen decision [8]. A common problem to be dealt by SMEs is limited initial investment or owned capital. This study revealed that apple dodol SMEs have limited capital for expanding their business scale, particularly for the 1st cluster which classified as small scale. Capital is an obligatory factor to be provided by any SMEs due to its direct impact to the business, especially in supplying materials for production purpose. Initial investment or capital is an active profit on approved and measured debt based on a standard accountancy [9]. Investment is the initial capital that must be issued by the business owner for the purposes of purchasing the needs associated with the production process. Initial investment has a critical influence on the production process wherein the initial investment is the input for financing the production process [10]. For any industry, the initial capital investment usually comes from two sources, include the owner investment and the profit acquired during the industrial production operation period. A less production capacity of the 1st cluster was due to a small number of manpowers and the limited capital owned by the SMEs, causing no additional funding can be added either to increase the raw materials capacity or to increase the production capacity. Production capacity is related to the income level of a business [11]. According to the Ministry of Cooperatives and SMEs in 1995, as stated in Indonesian regulation (UU No.9/1995) and Indonesian Bank (SK Dir BI No.30/45/Dir/UK on 5 January 1997), the 1st cluster of apple dodol SMEs is characterised as small-scale industry, while the 2nd cluster is as medium-scale industry. This characterisation is based on several indicators, such as: annual sales, total

asset, and total productive workers. Small-scale industry has an asset value indicator of less than IDR 200 million (excluding land and building) and the number of workforce between 6-19 people. While, medium-scale industry has an asset value indicator of less than IDR 600 million (excluding land and building) and labor force of more than 20 people. The total number of laborers owned by the SMEs has also a positive impact on their business income, in which having a higher amount of the productive laborers will create a more established industry [12]. The government or private parties may involve in developing the SMEs by facilitating knowledge and information technology transfer as well as establishing better information technology [13].

In this study, the hierarchy structure from industry development strategy determination consisted of four levels, include industrial cluster development, factor, purpose and alternative strategy. The industrial cluster development arrangement for each cluster employed the same hierarchy and expert respondents. The hierarchy of apple dodol SMEs cluster development for the 1st cluster can be seen in Figure 1. The figure shows that in the 1st cluster, the most contributing factor in level 1 is the government with a score of 0.56. While, in level 2, the purpose to increase product quality has the highest contribution score with the value of 0.40. In the case of alternative strategy (level 3), the quality improvement and product standardization strategy has the most contribution with a score of 0.44.

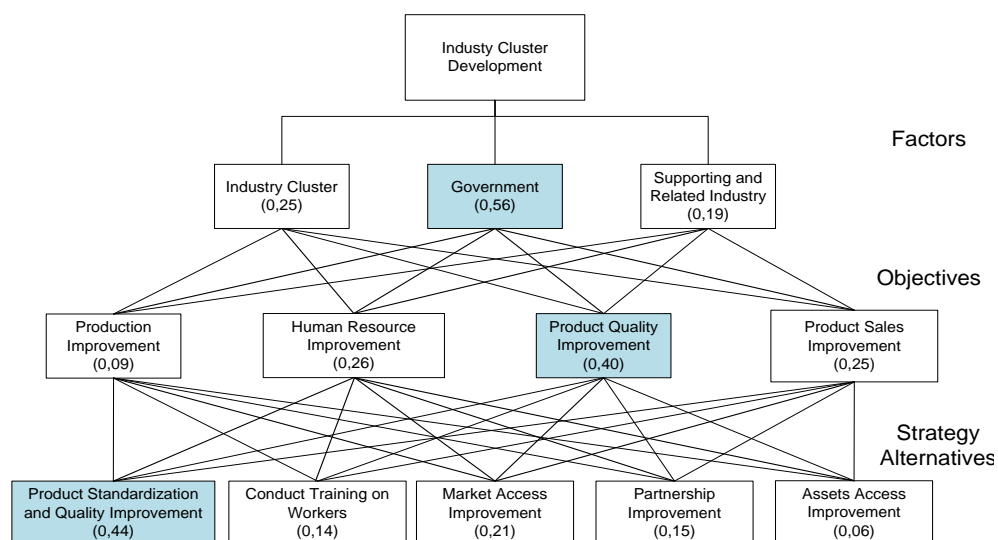


Figure 1. Hierarchy of apple dodol industrial cluster improvement for 1st cluster

This study revealed that the government has the biggest priority score of 56% in developing the apple dodol SMEs cluster. Therefore, in recent years, the Batu City government has established an Integrated Business Service Center (PLUT) facility, functioning as the central data office and the business help center. This facility exists to help either operating or starting up the business as well as to assist the SMEs in marketing and selling their products to several offices. This is relevant to the vision of SMEs Cooperatives Service and Trade Industry in Batu City to the establishment of strong, independent, growing and competitive cooperatives, SMEs, industry and trading. The government wants them to be the main contributor of Batu City economic activities, with the use of an equitable market mechanism [14].

To improve the SMEs in Batu City, the government established an Association of Batu City Entrepreneur (or APKB). APKB establishment is a group-based approach to solve problems faced by the entrepreneurs in Batu city. In the future, this approach is expected to make the problem solving process become easier. In addition, the government also established SMEs network, known as “*Guyub Rukun Agawe Santosa*” (or GRAS), under supervision of Batu City

DISKOPERINDAG and Department of Youth, Sport, and Labor (DISPORANAKER). The government facilitates the GRAS-participating SMEs based on related government policy and priority as well as business management supervision. The facilities provided can be an outlet to market their products or even machinery and production instruments. In comparison to public parties, the government should provide SMEs with public goods rather than private goods, to ensure a fair responsibility from the government. Furthermore, the government efforts to develop industrial cluster should be related to the facility compliance for small business development.

The top priority variable for development strategy was the product quality improvement. Taking this strategy in practice allows the apple dodol SMEs to improve their products. A better product quality produce by the SMEs will increase their consumer satisfaction, sales volume, competitiveness level, market, and price. A product can be considered as high in quality if the product has no defect [15]. The results show that the product quality improvement strategy and the product standardisation have the highest weight/priority. Product quality improvement strategy is essential to facilitate in getting business partners and loyal consumers. Consumer's loyalty can be acquired if the consumer satisfied with the product or the services, thus they have a strong commitment to buy and use the products/services continuously [16]. Therefore, this study suggested the apple dodol SMEs to maintain and improve their product quality.

The hierarchy of apple dodol SMEs cluster development for the 2nd cluster is shown in Figure 2. The figure shows that, at level 1, the related and supporting industry factor has the most contribution to the cluster development with a score of 0.61. While, in level 2, it can be seen that the product quality development has the most contribution to the purpose priority determination with a score of 0.37. In level 3, the market access enhancement strategy has the highest contribution to the alternative strategy of industrial cluster development, with a score of 0.28. This study indicated that the industrial cluster has 61% contribution, calculated based on the inputs required by SMEs to compete with other relevant industries. The achievement of business targets/objectives can be well acquired if the company is able to optimise their resource utilisation include man, money, methods, materials, machines and markets [17].

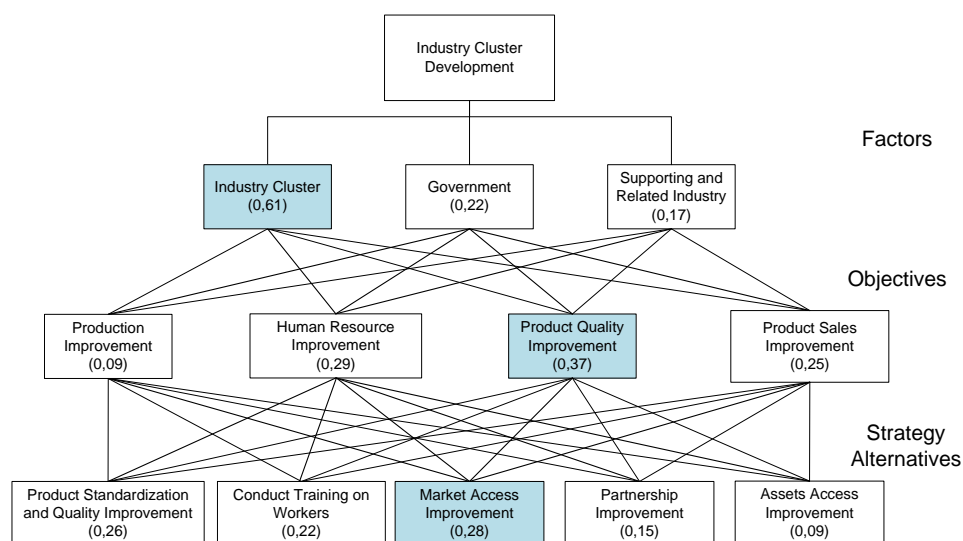


Figure 2. Hierarchy of apple dodol industrial cluster improvement for 2nd cluster

The results show that, in the 2nd cluster, the highest priority for improving the industry lies on the strategy of the product quality improvement. The study further confirmed that the quality of apple dodol products produced by the 2nd cluster SMEs was well maintained. It is obvious that, in the market, a selling price of a product is influenced by their quality. Therefore, having a

good quality product can increase the selling price as well as the consumer acceptance or satisfaction. The customers always place a priority on the product's quality over the price, to fulfill their satisfaction level. Quality is conformance to requirement, or corresponds to the standard [15]. A product can be considered to have good quality if it corresponds to the approved quality standard. This study also suggested that the market access enhancement strategy need to be applied by the 2nd cluster. Marketing can be defined as the highest level in fulfilling human needs and desires. Market channel is a series of organization or activity necessary to transferring the product ownership from production process of a product or service to the consumption [18]. Market channel does two important activities, such as product grouping and product distribution [19]. Therefore, to increase the market access, it is crucial for the 2nd cluster of apple dodol SMEs to building a strong market channel.

4. Conclusion

The findings in this study confirmed that *K-means* clustering method combined with AHP approach is a powerfull tool to determine the SMEs clusters and their development strategy priority. Several considerations are required to implement the *K-means* method, include the monthly production capacity, operating period, investment value, average sale per month, total asset possession and total labor. Using those considerations, apple dodol SMEs respondents were classified into two clusters categorised as small-scale (i.e. 1st cluster) and medium-scale (i.e. 2nd cluster). This study further suggested the following priority strategy to be applied by each cluster, include quality improvement and product standarisation for the 1st cluster and market access improvement for the 2nd cluster.

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