Clustering of potato chips SMEs in Batu City, Indonesia

N Z Wahdania, S A Mustaniroh*, I Santoso and I Purwaningsih
Department of Agroindustrial Technology, Faculty of Agricultural Technology, Universitas Brawijaya, Malang, Indonesia

E-mail: asmaul_m@ub.ac.id

Abstract. Batu City, Indonesia, has the local product potentials of potato chips with a number of 30 Small Medium Enterprises (SMEs). In improving their competitiveness, SMEs still have problems in product standardization, such as low communication and coordination in production and marketing among SMEs, Government, and marketing agencies. The research aimed to cluster the potato chips SMEs in Batu City for the business development strategy. The study method was the integration of k-means clustering and Fuzzy Analytical Network Process with 9 SMEs as respondents, which met the criteria required. The variables used in clustering are production capacity, number of workers, average turnover, length of operation, and halal certification status. The results showed that the SMEs of potato chips were formed in 2 clusters where cluster 1 (4 SMEs) of a micro-scale and cluster 2 (5 SMEs) of small-scale businesses. Cluster 1 developed the strategy by increasing access to capital, while cluster 2 through marketing access. The success rate of determining the SMEs industrial cluster development strategy will depend directly on the cooperation between institutions include core industries, supporting industries, raw material suppliers, and other supporting institutions.

1. Introduction
Industrial clusters in Batu City are one of the potential areas for potato farming, with a total production in 2019 reaching 94,014 quintals with a harvested area of 487 hectares based on the data of the Central Statistics Agency (BPS) of Batu City [1]. The development opportunities and prospects for potato farming increase the regional economy and farmers’ income [2]. The high volume of potato production can improve the utilization of potatoes into value-added products. One of them is potato chips. Potato chips are snacks that people commonly consume. They have delicious tastes, crisp and crunchy texture [3]. The fat and high salt content and acrylamide and trans-fatty acid are produced at the high-temperature frying process closely related to creating the taste, color, texture, and delicacy of potato chips [4]. In Batu City, potato chips production is mainly carried out by SMEs [5]. Referring to the Department of Agriculture of Batu City data, the number of SMEs processing the potato chips is 30 SMEs.

Industrial clusters are several companies and institutions concentrated in one area, which will support the competition that increases the productivity of the potato chips production. Moreover, this is because the needs of SMEs in accessing or obtaining resources can be concentrated in one place. A strategy to reduce partial conditions, strategies in describing and providing effective solutions to the existing problems are through forming industrial clusters, becoming a prerequisite for innovation, and enabling firms to apply new knowledge to the production. In addition, the competitive advantage also depends...
on the interactions within the technological community, which encourages local innovation and knowledge [6].

The problems faced by the potato chip SMEs include the lack of product standardization and the limited number of partners to build cooperation, which is mostly done individually and is one of the reasons why clustering has not yet been formed. This has an impact on the less optimal performance of each SME, thus there is a need for a clustering approach to the SMEs potato chip industry in Batu City which is expected to be able to increase its competitiveness [7].

The cluster analysis aims to classify n-objects based on p-variation which have similar characteristics between the existing objects. The objects will be classified into one or more clusters or groups. The method used for clustering is the K-Means method. The K-means method is a partitioning clustering method that separates data into different groups. It possesses some advantages, fast and quite efficient, to the grouping process in a large number of data [8]. The purpose of this study is to determine the clustering of potato chip SMEs used as a basis for developing the strategy and performance of SMEs.

2. Material and Methods

This research was conducted in Batu City on the nine (9) potato chip SMEs namely SMEs (A), (B), (C), (D), (E), (F), (G), (H), and (I). The variables used in grouping potato chip SMEs can be seen in Table 1. The cluster analysis with the K-means clustering method becomes the most widely-used method in data grouping in industrial fields. The first step that must be conducted in grouping applying the K-means clustering method is to determine the number of clusters (k) and the center value (centroid).

| Symbol | Variable                  |
|--------|--------------------------|
| X1     | Average turnover         |
| X2     | Production capacity      |
| X3     | Number of workers        |
| X4     | Length of operation      |
| X5     | Halal certification status |

This method has several advantages, i.e. it is fast and efficient enough to carry out the process of grouping large amounts of data [9] through the following stages:
- Determine k as the number of clusters formed
- Enter the initial k centroids (cluster center points) randomly

\[ V = \Sigma X_{ini} = 1; \ i = 1,2,3,...n \] (1)

Note:
V = centroid in cluster
Xi = object I
n = number of cluster member objects
- Calculate the distance of each object to each centroid of each cluster using Euclidian distance

\[ D(i,j) = (X_{1i} - 1j)^2 + (X_{2i} - 2j)^2 + \ldots + (X_{ki} - X_{kj})^2 \] (2)

Note:
D(i,j) = the distance of the i-th data to the center of the cluster
X_{ki} = i-th data on k-th data attribute
X_{kj} = j-th center point on k-th attribute
- Repeat the third step if the position of the new centroid is not the same

If the comparison matrix results are the same, the K-means cluster analysis algorithm has already been convergent. On the other hand, if they are different, it means they have not been convergent, so the
The next iteration needs to be made. The process of determining the number of clusters in this study was set at 2 clusters based on the current situation.

3. Results and discussion

The profile of potato chip SMEs can be seen in Table 2. Cluster 1 of potato chip SMEs has been operating for more than ten years, while in cluster 2 the length of operation of SMEs is around 6-17 years with an average of 11.2 years. The longer a business has been established, the greater the chance of having a high-level income. The income of an industry is influenced by the product sale and the amount of consumer demand [11]. Factors that influence product sales are affordable selling prices, a good service [12], and appropriate product quality. The income of a business is generated if the comparison between the good performance of production and marketing is balanced, then it produces a balanced income [13]. This is supported by many experiences and the mastery of skills business actors to innovate to increase the efficiency of SMEs and reduce the production costs. Profitability is a company's financial performance indicator. Moreover, effective operational activities, investment activities, and financing activities are crucially important to achieve the best financial performance [14]. The length of a business operation has a significant effect on the success of the business. Businesses that have been around for a longer time tend to be more growth businesses because the business actors have mastered various skills and have a lot of experience in running their businesses [15]. SMEs established for a long time but have not made significant progress even have lower incomes than SMEs with a shorter year of existence, it is necessary to evaluate and improve their performance [16].

| SMEs | Average of turnover per month (IDR) | The capacity of production (kg) | Number of workers (people) | Length of operation (year) | Halal certification status | Cluster |
|------|-----------------------------------|---------------------------------|----------------------------|----------------------------|---------------------------|---------|
| A    | 50,000,000                         | 40                              | 16                         | 10                         | Yes                       | 2       |
| B    | 70,000,000                         | 50                              | 12                         | 15                         | Yes                       | 2       |
| C    | 4,000,000                          | 20                              | 4                          | 6                          | Yes                       | 1       |
| D    | 20,000,000                         | 20                              | 8                          | 11                         | No                        | 1       |
| E    | 20,000,000                         | 60                              | 15                         | 15                         | Yes                       | 2       |
| F    | 10,000,000                         | 10                              | 4                          | 17                         | No                        | 1       |
| G    | 20,000,000                         | 10                              | 6                          | 15                         | No                        | 1       |
| H    | 30,000,000                         | 20                              | 10                         | 7                          | No                        | 1       |
| I    | 30,000,000                         | 65                              | 8                          | 10                         | No                        | 2       |

According to cluster 1 and cluster 2, the capacity and turnover of SMEs are not positively correlated because there are SMEs with more production capacity yet get a lower average turnover than other SMEs with less production capacity. As can be seen in Table 2, the cluster 1 SMEs (SMEs “C”, “D”, and “H”) have the same production capacity (20 quintals/month), but SME “H” has the highest average of turnover. Furthermore, for SMEs “F” and “G”, at the same production capacity (10 quintals/month), but SME “G” has a higher income turnover than UKM “F”. This is in accordance with research [17] which states that there is no correlation between efficiency and profitability.

In cluster 2, the turnover of SMEs “A” (with production capacity 40 quintals/month) and “B” (50 quintals/month) is higher compared to SMEs “E” and “I”, but actually, the production capacity of SMEs
“E” and “I” is higher than SME “A” and “B”. The production capacity of SME “E” is 60 quintals/month and 65 quintals/month for SME “I”. The efficiency of the SMEs’ performance could be positively related to the productivity of the company’s workforce depending on the effect they have on profitability and business growth. The initial investment is an aspect of investment used by the production process in achieving profits for a company [18] but the income turnover of SMEs “H” is higher than SMEs “C” and “D”. Still, the income turnover of SMEs “H” is higher than SMEs “C” and “D”. At the same production capacity (10 quintals/month), SMEs “G” has the highest income turnover than SMEs “F”. It is in line with the research [17] which states that there is no correlation between efficiency and profitability. At the same production capacity (10 quintals/month) SMEs “G” has the highest income turnover than SMEs “F”. It is in line with the research [17] which states that there is no correlation between efficiency and profitability.

Based on the labor variable, the two SMEs clusters have significant differences in the number of workers. Cluster 2, with high production capacity and income turnover, has a workforce of 8 people (I), 12 people (B), 15 people (E), and 16 people (A). Cluster 1, with relatively lower production capacity and turnover than cluster 2, has 4 workers (C and F), 6 workers (G), 8 workers (D), and 10 workers for SMEs “H”. In this case, the number of workers does not have a positive effect on the turnover or operating income. Furthermore, this indicates that the addition of workers to SMEs does not simultaneously increase the income and, similarly, the reduction of workers does not directly affect the decline in SMEs’ business income [19,18]. However, to improve company performance to achieve company profitability and efficiency can go through improving performance, improving managerial ability to take advantage of the potential of technology and human resources (labor) [18]. Labor is an important aspect as a determinant of the success of a production and business because it serves as the operator of the production process [20].

The halal certification label in cluster 2 is found in SMEs “A”, “B”, and “E”, while for cluster 1, halal certification is only owned by SMEs “C”. It is important for business actors in the food sector to provide clarity of halal status for products produced and marketed [21]. This is used as an effort to assure the halal of a food product that can increase consumer trust, especially for Muslim consumers. The purpose of halal certification for food business actors is to provide certainty of the halal status of a product and as an effort to fulfill consumer rights. The increased consumer trust in the halal of a product can affect the number of products they would purchase, including the level of product repurchased by consumers. The ownership of halal certification by producers is expected to improve the product quality and encourages the level of consumer trust [21].

Product sales affect the profit and the business development. The increase in production will be in line with the increase in the technologies’ production used to meet production capacity. The alternative strategies prioritized for potato chip SMEs cluster development include improving product quality and standardization. Product standardization will improve product quality in the market. Product standardization will make the more qualified products so that they can compete with other well-known products. Thus, market access will provide benefits for small businesses to market their products widely [22].

The analysis results from Table 3 indicate that the optimal k-means clustering in the 2 iterations with the minimum distance between the cluster centers was worth recognition (6.93). The centroid of each cluster was the point of the sum of the distances of objects in the cluster that has been minimized [10]. In potato chip SMEs, 2 clusters were formed classifying micro-scale (5 SMEs) and small (4 SMEs) as shown in Table 3. The classification of SMEs was based on Law No. 20/2008 concerning Micro, Small, and Medium Enterprises. The micro SMEs criteria were SMEs with a maximum turnover of IDR 300,000,000 in a year, while the small SMEs were SMEs with a maximum turnover in 1 year of more than IDR 300,000,000 to IDR 2,500,000,000. The clustering of SMEs makes possible to collaboration with the other member in the cluster such as government, researcher, supplier, distributor or the supply chain agent to increase the efficiency to increase the competitiveness of potato chips as a superior product from Batu City. The formation of clusters can foster work professionals, transform technology and knowledge, and increase competitiveness [9].
Table 3. The results of the potato chips SMEs clustering.

| No | Variable                                | Cluster 1 (C, D, F, G, H) | Cluster 2 (A, B, E, I) |
|----|-----------------------------------------|---------------------------|------------------------|
|    | Center of Cluster                       | Maximal                   | Minimal                | Maximal                   | Minimal                |
| 1  | Average Turnover per month (IDR)        | 16,800,000                | 30,000,000             | 4,000,000                 | 70,000,000             | 20,000,000             |
| 2  | Capacity Production (kg)                | 16                        | 20                     | 10                       | 53.75                  | 65                     | 40                     |
| 3  | Number of workers (people)              | 6.4                       | 10                     | 4                        | 12.75                  | 16                     | 8                      |
| 4  | Length of Operation (year)              | 11.2                      | 17                     | 6                        | 12.5                   | 15                     | 10                     |
| 5  | Halal Certification Status              | 1                         | 1                      | 0                        | 1                      | 1                      | 1                      |

4. Conclusions
The potato chip SMEs have two clusters namely, micro (5 SMEs) and small (4 SMEs). The clustering process used 5 indicators: the production capacity, the average monthly income, the number of workers, the length of production operation, and the ownership of halal certification. Thus, applying product quality standardization can be a development strategy for both clusters to increase market access and SMEs' profits.

References
[1] Statistics Central Bureau of Batu 2020 Produksi tanaman sayuran dan buah-buahan semusim menurut jenis tanaman di Kota Batu, 2018-2019 (Production of seasonal vegetables and fruits by plant type in Batu City, 2018-2019) https://batukota.bps.go.id/statictable/2020/05/15/740/produksi-tanaman-sayuran-dan-buah-buahan-semusim-menurut-jenis-tanaman-di-kota-batu-2018-2019.html. Accessed on 8 June 2021 [In Indonesian]
[2] Razak Z, Mappangaja A R, Bulkis S and Baharuddin 2015 Agribusiness development increasing the production of potato farmers in Gowa District, Indonesia Int. J. Curr. Res. Acad. Rev. 3 6 16-167
[3] Halagarda M and Grzegorz S 2016 The quality of salted potato chips available on the Polish market J. Econ. 8 956 71-86
[4] Abong G O, Okoth M W, Imungi J K and Kabira J N 2011 Effect of slice thickness and frying temperature on color, texture and sensory properties of crisps made from four Kenyan potato cultivars Am. J. Food Technol. 6 9 753–62
[5] Mustaniroh S A, Widyamanitas B A and Kamal M A 2021 Quality control analysis for minimizing of defect in potato chips production using six sigma DMAIC International Conference on Green Agro-industry and Bioeconomy 733 1-11
[6] Hu T S, Lin C Y, and Chang S L 2005 Role of interaction between technological and industrial clustering in innovative activity: the case of Hsinchu District, Taiwan Urban Stud. 42 7 1139-60
[7] Mustaniroh S A, Amalia F, Effendi M and Effendi U 2016 Strategi Pengembangan Klaster Keripik Apel dengan K-means Clustering dan Analytical Hierarchy Process (Development
strategy for cluster apple chips with k-means clustering and analytical hierarchy process) 

*Industria: J. Teknologi dan Manajemen Agroindustri* **5** 2 67-74 [In Indonesian]

[8] Kaur N K, Kaur U, Singh D 2014 K-Medoid clustering algorithm – A review *Int. J. Comput. Appl. Technol.* 1 1 42-45

[9] Silalahi R L R, Mustaniroh S A and Astrianti N 2019 Integration of K-Means clustering and fuzzy AHP to establish development strategy on cassava chips produced by SMEs *Int. Conf. Green Agro-industry and Bioeconomy* **230** 1-6

[10] Dhanachandra N 2015 Image Segmentation Using K-Means Clustering Algorithm and subtractive Clustering Algorithm *Proc. Comp. Sci.* **54** 6 764-771

[11] Bonu N S and Pedro, MP 2009 The impact of income tax rates (ITR) on the economic development of Botswana *J. of Account. Tax.* **01** 01 008-022

[12] Sun S and Qin K 2007 Research on modified k-means data cluster algorithm *Comp. Eng.* **33** 13 5-25

[13] Cowell R G 2013 New product strategies: what distinguishes the top performers? *J. Prod. Innov. Manag.* **01** 03 151-4

[14] Azim M D, Ahmed H and Khan A T M S 2015 Operational performance and profitability: An empirical study on the Bangladesh ceramic companies *Int. J. Entrepreneurship Dev. Studies.* 3 1 63-73

[15] Julyanda I and Rejeki D 2018 Pengaruh jenjang pendidikan, ukuran usaha, lama usaha dan latar belakang pendidikan atas penggunaan informasi akuntansi terhadap keberhasilan usaha (Studi kasus pada UKM di PIK Pulogadung) (The effect of education level, business size, length of business and educational background on the use of accounting information on business success (Case study on SMEs at PIK Pulogadung)) *J. Akuntansi & Bisnis Krisnadwipayana* **5** 1 14-31 [In Indonesian]

[16] Nainggolan R 2016 Gender, tingkat pendidikan dan lama usaha sebagai determinan penghasilan UMKM Kota Surabaya (Gender, education level and length of business as determinants of income for SMEs in Surabaya) *KINERJA* **20** 1 1-12 [In Indonesian]

[17] Keramidou I, Mimis A and Fotinopoulou A 2012 Exploring the relationship between efficiency and profitability *Benchmarking: An Int. J.* **20** 5 647-660

[18] Ghobadian A, Speller S and Jones M 2011 Service quality: concepts and models *Int. J. of Qual. Reliab. Manag.* **11** 09 1-20

[19] Polandos P M, Engka D S M and Tolosang K D 2019 Analisis pengaruh modal, lama usaha, dan jumlah tenaga kerja terhadap pendapatan usaha mikro kecil dan menengah di Kecamatan Langowan Timur (Analysis of the effect of capital, long of business, and number of labor on income of small and medium micro businesses in East Langowan District) *J. Berkala Ilmiah Efisiensi* **19** 4 36-47 [In Indonesian]

[20] Doepke M and Fabrizio Z 2009 International labor standards and the political economy of child-labor regulation *J. of the Eur Econ. Assoc.* **07** 01 508-18

[21] Akim Konety N, Purnama C and Adilla M H 2018 Pemahaman usaha mikro, kecil dan menengah (UMKM) di Jatinangor terhadap kewajiban sertifikasi halal pada produk makanan (Understanding of Micro, Small and Medium Enterprises (MSMEs) in Jatinangor on the Obligation of Halal Certification in Food Products) *Kumawula: Jurnal Pengabdian Kepada Masyarakat* **1** 1 31-49 [In Indonesian]

[22] Lenzun J, James D and Decky A 2014 Pengaruh kualitas produk, harga, dan promosi terhadap kepuasan pelanggan kartu prabayar Telkomsel (Effect of product quality, price, and promotion on Telkomsel prepaid card customer satisfaction) *Jurnal EMBA* **2** 3 1237-45