

Strategy for Increasing MSME Halal Certification, Identifying Characteristics of MSME Actors Using the K-Means Approach

UNDERGRADUATE THESIS

**Submitted to the International Undergraduate Program in Industrial Engineering in
Partial Fulfilment of Requirement for the Degree of Sarjana Teknik at the Faculty of
Industrial Technology
Universitas Islam Indonesia**



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2024**

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Demikian surat keterangan kami keluarkan, agar dapat dipergunakan sebagaimana mestinya.

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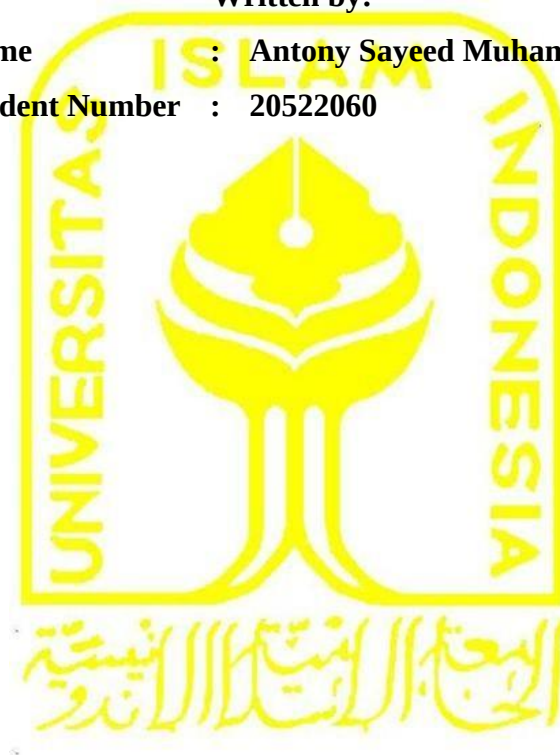
**Strategy for Increasing MSME Halal Certification, Identifying
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DEDICATION PAGE

Bismillahirrahmanirrahim

Alhamdulillahirabbil'alamin

I dedicate this final assignment to you with great gratitude. I would like to convey this final assignment to the people I love and care about. Thank you for all your invaluable struggle, prayers, love, enthusiasm, and attention until I completed my bachelor's degree in industrial engineering at the Islamic University of Indonesia.

My supervisor, Mrs. Harwati, S.T., M.T. is an academic supervisor whom I respect and who has provided great direction, guidance, and patience in guiding my final project.

MOTTO

*“And do not feel weak and do not be sad
because you are the highest in rank if you are believers.”*

QS. Ali Imran: 139

PREFACE

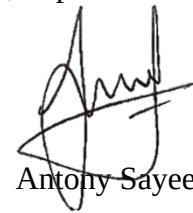
I give all praise and gratitude to Allah SWT for all His mercy and grace which has enabled me to carry out and complete this undergraduate thesis as well as possible, entitled “Strategy for Increasing MSME Halal Certification, Identifying Characteristics of MSME Actors Using the K-means Approach” I pour out my prayers and greetings to the Prophet Muhammad SAW, his family, his friends, and his followers until the end of time. In writing this undergraduate thesis, there is also a lot of help, guidance, support, and prayers from various parties so that the researcher can solve the problems faced. Therefore, on this opportunity, the researcher would like to express many, very big thanks to:

1. Mr. Prof. Dr. Ir. Hari Purnomo M.T., as the Dean of the Faculty of Industrial Technology, Universitas Islam Indonesia.
2. Mr. Dr. Drs. Imam Djati Widodo, M. Eng. Sc., as the Head of the Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Islam Indonesia.
3. Mr. Ir. Muhammad Ridwan Andi Purnomo, S.T., M.Sc., Ph.D., IPM., as the Head of the Undergraduate Program in Industrial Engineering, Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Islam Indonesia.
4. Mrs. Dr. Harwati, S.T., M.T. serves as the supervisor for the undergraduate thesis as well as the academic supervisor who has provided guidance and assistance in preparing this undergraduate thesis Report.
5. The researcher's parents and elder sibling consistently provide invaluable prayers, love, encouragement, and very precious attention to the researcher.
6. Researcher friends, both Industrial Engineering friends and those outside the Industrial Engineering who have already understood and helped in providing support to researchers.
7. All related parties cannot be mentioned one by one; that's to help researchers complete this final task and complete it with a bachelor's degree in engineering, industry, Islamic University, Indonesia.

The researcher acknowledges that the undergraduate thesis report, authored with limitations in knowledge, insight, and experience, may still contain imperfections and shortcomings, whether intentional or unintentional. The researcher hopes this report will prove beneficial and bring blessings of knowledge to its readers, especially within the Industrial Engineering community at the University of Islam Indonesia. Constructive criticism and suggestions for improvement are welcomed to enhance future reports towards greater excellence. May Allah SWT reward all contributors for their kindness, both spiritually and materially, and may their efforts be counted as righteous deeds. Aamiin.

Wassalamu'alikum Warahmatullahi Wabarakatuh

Yogyakarta, September 23rd 2024



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ABSTRACT

The rapidly growing and popular business trend in Indonesian society is the micro, small, and medium-sized enterprises (MSMEs), which have had a significant impact on national GDP growth in recent years. The managers of these MSMEs face a variety of challenges, particularly in providing services or products that guarantee customer satisfaction. In recent years, there has been a strong association with the halal industry, which aims to ensure that all goods or food providers deliver high-quality products while adhering to halal standards in terms of ingredients and processes used. MSME operators are required to register their products or services for halal certification, which positively impacts customer perceptions. Specifically, in the Special Region of Yogyakarta, various types of MSMEs have developed, but many still lack halal certification. This study aims to understand the operational standards implemented by MSME business owners based on their participation in halal certification. The K-Means clustering method is used to illustrate the readiness and availability of halal certification in MSMEs, which could boost the halal industry in Yogyakarta. This clustering process utilizes various supporting variables identified during the research methodology phase, particularly concerning the halal certification status of these MSMEs. Based on the results of the K-Means clustering analysis, three clusters were formed, each containing several MSMEs with similar characteristics as determined by the average values of each variable. Additionally, two clusters were identified as having the potential to receive recommendations, and these recommendations were made by considering the conditions and capabilities of the MSMEs within those clusters. The primary focus is to promote and encourage the adoption of halal certification in MSMEs. This could greatly benefit businesses by enabling effective marketing strategies, increasing sales, and maintaining business continuity.

Keywords: Halal Certification, Halal Industry, K-Means Clustering, MSMEs, Yogyakarta.

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CHAPTER I

INTRODUCTION

1.1 Background

Micro, Small, and Medium-sized Enterprises (MSMEs) in Indonesia aim to increase income by creating many convenient job opportunities and fostering economic growth. Furthermore, these enterprises have been widely recognized for their positive contribution to the local industry. Effective government policies regarding investment and expenditure can promote MSMEs and drive economic development (Prasetyo et al., 2020). Based on data from the Ministry of Cooperatives and SMEs, the current number of MSMEs has reached 64.2 million, with a contribution to GDP of 61.07%, equivalent to 8,573.89 trillion rupiahs. MSMEs contribute to the Indonesian economy by absorbing 97% of the total workforce and gathering up to 60.4% of total investments. However, Indonesia's high number of MSMEs also accompanies existing challenges (Nugroho, 2018).

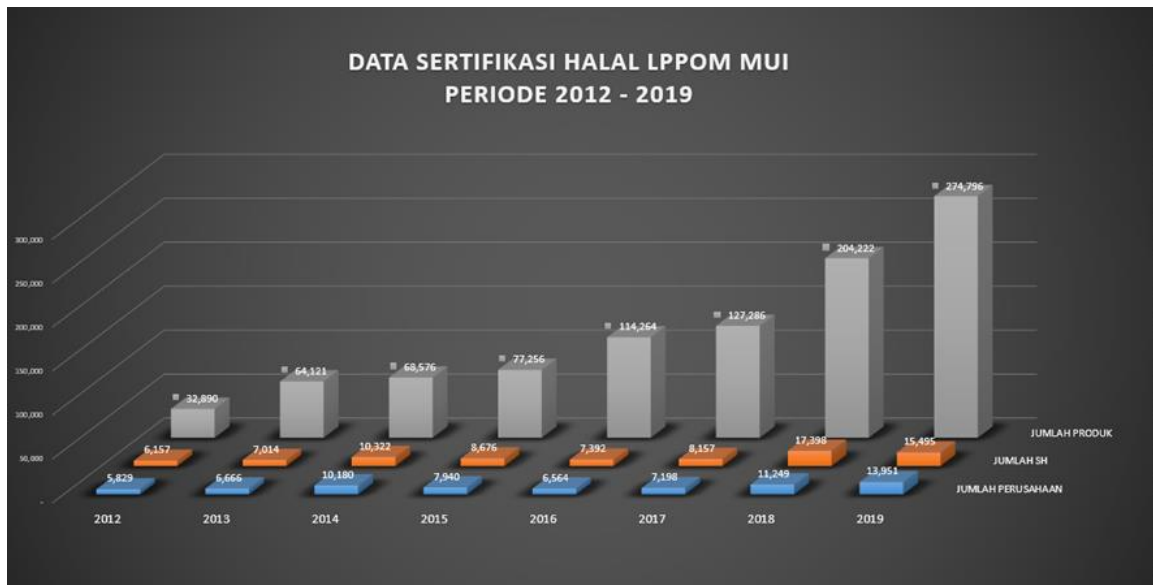


Figure 1. 1 Halal Certification Data LPPOM by MUI

In recent years, the halal industry has become a trend in several countries, including Indonesia. A country with a dense population whose majority is Muslim requires attention to food products that circulate freely, namely not only paying attention to the composition that offers medical health but also ensuring that the food is halal for consumption (Fuadi et al., 2022). Data from the Central Statistics Agency also shows that the number of SMEs in Indonesia is 65 million, but there are still very few that already have halal certificates. According to data from the

Indonesian Ulema Council, as the institution authorized to issue halal certification, in the 2012-2019 period, national halal certificates for 69.577 MSMEs were issued. Thus, only 0.11% of businesses are registered compared to the number of MSMEs based on data from the Ministry of Cooperatives and SMEs in 2019 of 65 million MSMEs (Waharini & Purwantini, 2018). This data means that millions of MSMEs still need to implement halal certification. The Indonesian government is currently trying to encourage MSME players to help the growth of the halal product industry by requiring every MSME to register for halal certification.

Halal certification is issued by the Food, Drug, and Cosmetic Research Institute (LPPOM-MUI), which states that a product is under Islamic law. This halal certificate can be used to make halal labels. The Law No. 33 of 2014 concerning Halal Product Guarantees seeks to resolve public concerns by providing clear rules regarding the issuance of halal certificates. The Halal Certificate is a form of recognition of the halal level of a product issued by BPJPH based on a written halal fatwa issued by the MUI. Meanwhile, the halal label is a sign that a product is halal. Business actors who have obtained a halal certificate must include a halal label on their products per the nationally applicable halal label form (Fuadi et al., 2022).

By looking at the context of regulations and economic development policies, it cannot be denied that halal-based industries are currently developing rapidly in Indonesia. This condition means every entrepreneur must understand halal standards, including certification obligations Halal on products. Most MSMEs currently need to be made aware of the benefits of halal certification itself. All food and beverage MSMEs must have halal certification to sell products throughout Indonesia. If it does not have halal certification, processed food and beverage products can be withdrawn from circulation by the government (Khairunnisa et al., 2020).

Based on the problems above, a strategy is needed to assist the Indonesian government in dealing with MSMEs that do not yet have halal certification. This strategy involves immediately registering their businesses to obtain halal certification using the K-Means clustering method. This method carries out analysis by grouping according to the characteristics of each cluster. This method aims to find strategies for handling the cases in this research.

This research was grouped based on MSMEs located in the Special Region of Yogyakarta Province because very few MSMEs still need to register for halal certification in the Special Region of Yogyakarta. Hopefully, this research can also provide input to assist The

government in overcoming the problems by focusing on halal certification in MSMEs in the Special Region of Yogyakarta.

1.2 Problem Formulation

Based on the background information above, the problem formulation is as follows:

1. Do demographic variables, knowledge, attitudes, interests, information access, costs, awareness, and concerns significantly influence strategies to encourage MSMEs to register for halal certification based on associated MSME behavioral characteristics?
2. How many and what are the behavioral characteristics of each cluster formed?
3. What is the strategy to encourage MSMEs to register for appropriate halal certification based on the results of MSME clustering in the Special Region of Yogyakarta?

1.3 Research Objectives

The objectives of this research objectives are as follows:

1. Identify demographic variables, knowledge, attitudes, interests, access to information, costs, awareness, and concerns that significantly influence the strategy variables to encourage MSMEs to register for halal certification based on the characteristics of related MSMEs.
2. Identify the number of clusters and behavioral characteristics of each cluster formed.
3. Based on the results of MSME clustering in the Special Region of Yogyakarta, develop a strategy to encourage MSMEs to register for appropriate halal certification.

1.4 Research Limitations

The limitations of this research are as follows:

1. Data collection was carried out by distributing online and offline questionnaires.
2. The questionnaire used is a Google Form questionnaire.
3. The research focuses on MSME actors in the Special Region of Yogyakarta.

1.5 Research Benefits

It is hoped that the research's results can help the Special Region of Yogyakarta Government encourage MSMEs who do not yet have halal certification to register for halal certification.

1.6 Systematic Research

CHAPTER I INTRODUCTION

This section contains the background of the problem, its formulation, its limitations, the aims of the research, its benefits, and the systematization of the undergraduate thesis report.

CHAPTER II LITERATURE REVIEW

This section contains deductive and inductive literature studies, which can be useful as a theoretical basis for researchers, as the research topics raised are related to previous research theories.

CHAPTER III RESEARCH METHOD

This chapter describes the method, flowchart diagram, and steps taken in the research, namely, the research object, the data used, and the stages carried out by the researcher.

CHAPTER IV DATA COLLECTION AND PROCESSING

This section contains a description of the data processing process including images and tables of data calculation results which will be used as discussion in the following chapter.

CHAPTER V DISCUSSION

This section discusses the results of the data processing carried out in the research. The discussion is then used as a basis for recommending improvements to the problem and further research.

CHAPTER VI CONCLUSION AND RECOMMENDATION

This chapter contains conclusions from the discussion that has been carried out by answering the problem formulation in the previous section and suggestions for further research.

CHAPTER II

LITERATURE REVIEW

2.1 Theoretical basis

2.1.1 Micro, Small, and Medium Enterprises (MSME)

MSMEs are activities with a narrow or small scope related to the community's economy, aiming to fulfill income, and ownership of these activities has legal regulations (Hamdani et al., 2019). According to statutory regulations No. 20 of 2008 concerning micro, small, and medium enterprises (MSMEs), businesses are founded based on personal wishes in the economic sector. They are established in the name of individuals or business entities not part of a company or branch. Where the branch in question is still part of the company. From a business perspective, according to Bank Indonesia (2015), MSMEs are divided into four groups, namely:

1. Micro SMEs consist of small businesses that typically possess artisan skills but often lack the entrepreneurial spirit needed to expand and develop their ventures. They usually focus on the technical aspects of their work and face challenges in terms of innovation and broader growth strategies.
2. SMEs in the informal sector, such as street vendors, often reflect a fast-moving and adaptive economic dynamic, but they still face challenges in accessing resources and navigating regulations. Other examples of SMEs in the informal sector include small roadside shops and mobile food vendors.
3. Fast Moving Enterprise is a small and medium-sized enterprise (SME) with strong entrepreneurial skills and is ready to grow into a large company. With a solid foundation, they are on the path to transforming into a more advanced and successful business.
4. Dynamic Small Business is a group of MSMEs that can become a center for business development in the future, namely:
 - a. Providing employment opportunities in the small industrial business sector, which can absorb up to 50% of the available workforce
 - b. Small and medium enterprises have so far proven capable of creating new entrepreneurs that can generate the growth and development of new entrepreneurs.

- c. It has a unique market business section uses simple and flexible management of possible market changes.
- d. Being able to utilize natural resources, small industries can mostly utilize waste or results from large industries or other industries.
- e. Has the potential to develop.

Micro, small, and medium enterprises (MSMEs) are crucial in strengthening the economy and reducing social disparities. The government's attention to MSMEs is evident through the establishment of MSME and Cooperative platforms under the Ministry of Cooperatives and SMEs. This support reflects the government's appreciation for the contribution of MSMEs in advancing the economy and improving societal welfare. Also, MSMEs contribute to poverty alleviation, equalizing the economic status of small communities and generating foreign exchange for the country (Kadeni & Srijani, 2020).

2.1.2 Halal Certification

According to research by Ghadikolaei (2016), a Halal certification mark signifies an assurance for Muslim and non-Muslim customers regarding their purchases. Concerning edibility conforming to Islamic principles in Indonesia, solely the halal authentication stamps endorsed by LPPOM MUI carry validity as unequivocal symbols denoting legitimately permitted culinary options. During the span of the previous few years (2011-2018), records indicate that LPPOM MUI had authorized almost sixty thousand halal designations out of roughly six hundred and fifty thousand merchandise entries evaluated (Badan Penyelenggara Jaminan Produk Halal, 2020). Halal certification acts as a testament confirming that a product aligns with Islamic precepts, strictly complying with regulations surrounding components utilized, fabrication procedures, distribution channels, and preservation measures (Jaiyeoba et al., 2020).

2.1.3 Data Mining

Data mining is a technique that involves the extraction of valuable information using statistics and machine learning to identify useful data (Naldy & Andri, 2021). Data Mining is a potent asset for organizations seeking to extract vital insights from their data repositories. These tools enable the anticipation of future trends and behaviors, facilitating informed decision-making. The escalating volume of data, encompassing business transactions, scientific data, sensor data, images, and videos, necessitates a system capable of distilling pertinent information and

autonomously generating reports, views, or data summaries to enhance decision-making (Azevedo, 2019).

Knowledge Discovery in a Database (KDD) is a nontrivial process useful for searching and identifying patterns within data. The patterns discovered must be true, useful, and understandable. KDD can also be defined as an automated process for identifying useful true patterns that can be found within large and complex data sets (big data) (L. Cao & Zhang, 2007). Below is the process of Knowledge Discovery in a Database.

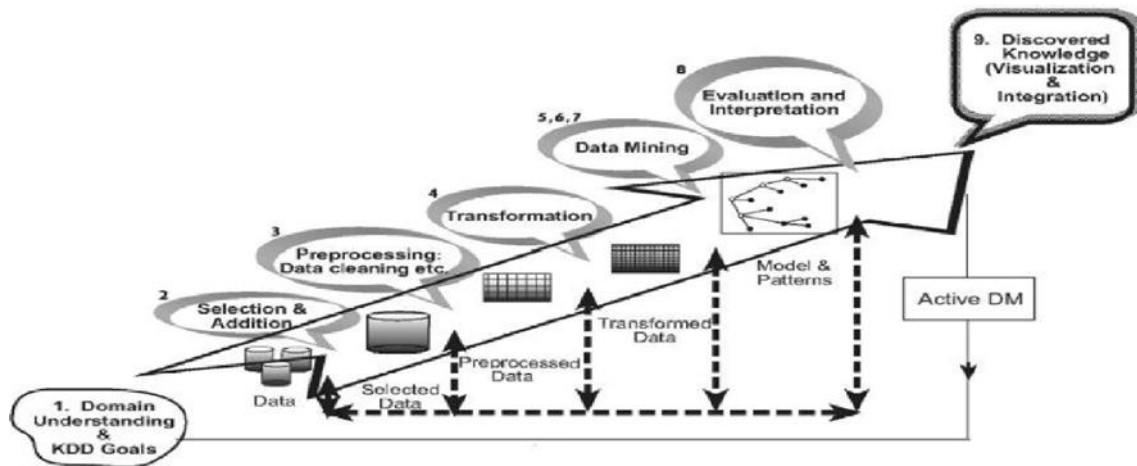


Figure 2. 1 Knowledge Discovery in Database Stages

The KDD process begins by identifying its goals and culminates by applying the acquired knowledge. The Active Data Mining phase follows, which is not covered in this book, or the process outlined here. Consequently, changes must be made in the application domain, such as providing distinct features to mobile phone users to reduce churn. This closes the loop, and the effects are measured on new data repositories, prompting the relaunch of the KDD process. According to Markusheski et al., (2019), The nine-step KDD process will be described below;

1. Gaining knowledge about the application domain

This preparatory phase establishes the foundation for comprehending the necessary actions concerning transformations, algorithms, representations, and so forth. Those responsible for overseeing a KDD project must grasp and specify the user's objectives and the context wherein the knowledge discovery process will occur (considering relevant existing knowledge). Throughout the progression of the KDD process, this initial step may be reassessed.

2. Choosing and assembling a data set for discovery

Identify the necessary data after defining the goals to ensure successful knowledge discovery. This involves assessing available data, obtaining essential data, and integrating it into a single dataset with significant attributes. While considering more attributes enhances analysis, there is a tradeoff between comprehensive data management and cost. This balance reflects the interactive and iterative nature of the KDD process, starting with the best available dataset and gradually expanding to observe the impact on knowledge discovery and modeling.

3. Preprocessing and cleansing

In this stage, enhance data reliability through cleaning, addressing missing values, and removing noise or outliers. The handbook offers various strategies, from minor to major involvement in KDD projects. This stage may involve statistical techniques or Data Mining algorithms. When an attribute raises concerns due to insufficiency or excessive missing data, it becomes the focus of a supervised data mining algorithm. Attention to this stage varies based on multiple factors, but studying these aspects remains crucial, especially for enterprise information systems.

4. Data transformation

Data Transformation involves generating and refining optimized data for Data Mining. This stage includes techniques such as dimensionality reduction (e.g., feature selection and extraction, record sampling) and attribute transformation (e.g., numeric attribute discretization, functional transformation). The KDD process evaluates itself and determines the necessary transformations. After completing the first four steps, the subsequent four steps focus on the Data Mining component, specifically the algorithmic aspects utilized for each project.

5. Optimal Data Mining tasks must be chosen.

The next step in the data mining process is to choose between classification, regression, or clustering. This decision mostly relies on the KDD objectives and previous stages.

6. Selecting an algorithm for data mining

This step involves deciding on the strategy and choosing the precise approach to employ when looking for patterns.

7. Employing the Data Mining algorithm

This stage implements the Data Mining algorithm. It may require multiple attempts to obtain satisfactory results, such as modifying the algorithm control parameters, including the minimum number of instances in a decision tree single leaf.

8. Evaluation

Assess and interpret extracted patterns according to initial objectives. Account for pre-processing impact on data mining outcomes. This step prioritizes the model's intelligibility and practicality. Record the uncovered knowledge for future reference. Last, deploy data mining patterns and discovery findings and receive feedback.

9. Using the discovered knowledge

With our knowledge now integrated into another system, we are poised to implement further actions. Knowledge assumes an active role, permitting us to introduce modifications to the system and gauge their consequences. Indeed, the efficacy of this step dictates the overall success of the KDD process.

2.1.4 Cluster

Grouping a data set into clusters that share similarities is called a clustering technique which aims to partition the collection into separate segments characterized by the same characteristics. Each group should show a higher internal affinity compared to the analogy that can be seen between members belonging to different factions. Data clustering is part of the tools embedded in data exploration. At its heart lies the goal of categorizing subjects based on mutual similarity (Burhan et al., 2018).

A collective assembly constitutes a set of comparable data elements. These data points are categorized within distinct groups based on their resemblance, with dissimilarities distinguishing one cluster from another. The capability for clustering enables discerning underlying structures present in datasets. This technique finds utility across diverse domains like classifying information, enhancing imagery analysis, and identifying patterns (Bani et al., 2022). In data mining, the main effort is to apply cluster definition techniques from the basis of datasets powerfully and efficiently. Among the important requirements in the clustering process include flexibility of scale, the ability to deal with feature variations, response to high degrees of dimensionality, data management that includes information breakdown, and easy-to-implement transparency support.

2.1.5 K-Means

K-Means is an algorithm for partitioning groups by partition. A unique identifier separates each batch. This algorithm implements a non-hierarchical data grouping technique. The procedure involves dividing the data into one or more clusters or groups. In K-Means, an algorithm separates data into different groups by carrying out structural restrictions. K-Means applies an algorithm to separate data into different groups by partitioning. The distance between the data and the cluster must be minimized (Musharyadi et al., 2017).

The K-Means algorithm is a non-hierarchical approach that starts with selecting population components to become the initial cluster core. In essence, the cluster core position is searched randomly from a subpopulation of data. Then, K-Means tests each population component and determines it as a component of only one core of the planned cluster based on the minimum distance between that component and each cluster. The cluster core points are calculated again until all data components are grouped into each cluster core and determine the position of the new cluster core. Below are the following of advantages and disadvantages of K-Means clustering from research by Saxena et al., (2017), namely.

Advantages:

1. Simple: Simple to learn and apply.
2. Efficient: The $O(t.k.n)$ time complexity makes working with large data sets possible.

Disadvantages:

1. K-Means may perform more quickly when the 'K' value is kept relatively low.
2. Useful only in cases where the mean is known.
3. Unsuitable for data with high dimensions.
4. Sensitive to noise.

According to research conducted by (Abbas et al., 2020), the K-Means method tries to minimize the squared error between the average of each cluster and the data points located within it. The basic concept is breaking a multi-dimensional dataset into μk homogeneous groups by realizing an optimal arithmetic mean ("mean", a cluster representation). For example, suppose we have several multidimensional data points that want to form k number of clusters by averaging each cluster. In that case, the K-Means algorithm can be formulated as follows:

$$j = \sum_{i=1}^n \sum_{i=1}^k a \quad D(x_1, c_1)^2 \quad (1)$$

Where x_i is a set of data points with $i = 1, 2, 3, \dots, n$, to be grouped in clusters from a set of clusters given as c_k with $k = 1, 2, 3, \dots, k$. To reduce squared error, k-means allocates patterns to k clusters that are initially partitioned. Regarding membership clusters that do not determine, k-means repeat the following steps (Abbas et al., 2020).

2.2 Literature Review

Table 2. 1 Literature Review

No.	Title	Method	Object	Outer	Results
1.	Comparison of K-Means and K-Medoids Algorithms for Grouping Landslide Prone Areas in West Java Province. (Herviany et al., 2021)	K-means and K-Medoids	Soil Character	Cluster grouping to determine the characteristics of landslides.	It can be concluded that grouping uses the K-Means method more optimal than the K-Medoids method on landslide occurrence data West Java Province in 2019 with the most optimal k number being $k = 6$. Cluster acquisition is dominant, indicating that cluster 2 has the largest number of areas. Moreover, The highest number of incidents is located in cluster 5 with the number of regions being 4 regions and the number of incidents a total of 106 incidents.
2.	K-Means and K-Medoids: Cluster Analysis on Birth Data Collected in City Muzaffarabad, Kashmir.	K-means and K-Medoids	Birth Data	Researchers collect data reflecting general sociocultural, economic, and physical	Employing K-means and K-medoids clustering on local birth data, we examined clustering capacities with diverse distance metrics. Implementing

No.	Title	Method	Object	Outer	Results
	(Abbas et al., 2020)			characteristics among women to evaluate the method's performance and produce accurate results regarding the resulting group.	data transformations led to a maximum accuracy of 72.64% via Rank K-medoids+SEV+Yeo-Johnson. Results linked greater Cesarean odds to young matrimony, familiar connections, strained pros facing challenges, and changing boy-girl proportions. Groundbreaking in sizeable cities, continuous joint explorations foster stronger healthcare infra and communal growth.
3.	Sugeno Fuzzy Inference Optimization With Firefly and K-Means Clustering Algorithms for Rainfall Forecasting. (Burhan et al., 2018)	Firefly Algorithm, K-Means Clustering, and Sugeno Fuzzy	Rainfall Prediction	Cluster grouping of character of temperature, humidity, and wind speed.	The combination of Sugeno fuzzy method and K-Means clustering for rainfall prediction has been shown to produce reasonably accurate results. The test data obtained from the experiment showed an accuracy range of 30% to 75%, which is a significant improvement. This demonstrates that

No.	Title	Method	Object	Outer	Results
					the K-Means algorithm can accurately predict precipitation when used in conjunction with the fuzzy method.
4.	K-Means Clustering for Persistent Homology. (Y. Cao et al., 2024)	K-Means Clustering	Data Topology	Grouping based on characteristic topology.	<p>Based on empirical evidence, the author discovered that clustering results on persistence diagrams and persistence measures were superior to those on vectorized persistence diagrams. This implies a loss of structural information in the most used persistence diagram embeddings.</p> <p>This could encourage the development of more precise persistence diagram embeddings for machine learning. Another potential avenue for future research is modifying other clustering techniques, such as deep learning-based methods, for persistent homology. This would enable a comprehensive</p>

No.	Title	Method	Object	Outer	Results
					exploration of various statistical and machine learning approaches for clustering in persistent homology.
5.	A Review of Clustering Techniques and Developments. (Saxena et al., 2017)	Hierarchical, Single linkage, Complete linkage, Average linkage, K-Means, Fuzzy C-Means.	Clustering Method	Authors understand more deeply popular cluster techniques and identify challenges in cluster techniques.	The paper discusses clustering methods, focusing on hierarchical, partitional (k-means), graph theoretical, mixture density-based, grid-based, and evolutionary approaches. It highlights application areas such as image segmentation, object recognition, information retrieval, and data mining. These methods ' fundamental concepts and strengths/weaknesses are covered, alongside similarity metrics and cluster evaluations. Despite extensive literature on clustering, this paper concentrates on essential and relevant methods.
6.	A comprehensive survey of clustering algorithms: State-	K-means, Fuzzy Clustering	Cluster algorithm are	Understand more deeply popular cluster	The results of this study indicate that the fields of bioinformatics, financial and

No.	Title	Method	Object	Outer	Results
	of-the-art machine learning applications, taxonomy, challenges, and future research prospects. (Ezugwu et al., 2022)		popular in the context of advanced machine-learning applications.	techniques and identify challenges that arise in cluster techniques.	economic systems, image processing, and segmentation are gaining more research interest than other domains such as data mining and object recognition. This document also shows that the K-Means and Fuzzy algorithms are one of the cluster algorithms that are very popular in practical applications.
7.	Implementation of Halal Certification (Study on Non-Muslim MSMEs in Palangkaraya City). (Sabran et al., 2022)	several theories namely the theory of legal certainty, law enforcement, legal effectiveness, and maslahah murshalah	Halal certification for non-Muslim MSMEs occurs in Palangkaraya City	Looking for reasons why many non-Muslim MSMEs need to register for halal certification.	Regarding halal certification in non-Muslim restaurants in Palangkaraya City, there are a few restaurants owned by non-Muslim owners that have halal certification. This is caused by a lack of understanding about halal certification and a lack of outreach that does not reach them. Apart from that, restaurant entrepreneurs need to register their products with BPJPH because of the high costs and the lack of penalties for

No.	Title	Method	Object	Outer	Results
					those who do not carry out halal certification.
8.	Performances of K-Means Clustering Algorithm with Different Distance Metrics. (Ghazal et al., 2021)	K-Means Clustering	Different distance metrics	Making clusters to compare to determine the most optimum running time of the k-means algorithm with three different metrics and models.	The K-Means clustering algorithm is widely used to identify similar data objects using different distance metrics. This study compared the performance of three metrics (Minkowski, Manhattan, and Euclidean) across different datasets and numbers of clusters (4-16). Manhattan Distance performed best for 4, 8, 12, and 14 clusters, while Euclidean Distance was better for 6 and 16 clusters. Minkowski Distance only performed better for 10 clusters. Future research will explore extending this approach to partition-based clustering algorithms such as K-Medoids, CLARA, and CLARANS.

No.	Title	Method	Object	Outer	Results
9.	An intrusion detection method for the Internet of Things based on suppressed fuzzy clustering. (Liu et al., 2018)	Fuzzy Clustering	The data is initially categorized into high-risk and low-risk categories, identified by their high and low frequencies.	Grouping high-risk and low-risk data, then identifying which one is identified as the most optimum.	IoT is susceptible to external attacks and requires an effective intrusion detection system. IoT intrusion detection methods based on SFC and PCA algorithms can classify data into high-risk and low-risk categories and detect them with different frequencies. Experimental results show increased effectiveness of this method compared to conventional methods. This method proposes innovation in detecting IoT intrusions with initial predication and frequency expansion.
10.	Klasterisasi Dana Bantuan Pada Program Keluarga Harapan (PKH) Menggunakan Metode K-Means. (Azis et al., 2021)	K-Means Cluster	This research uses data obtained from the 2019 annual plantation data	Grouping clusters based on village name, subdistrict, and distribution stage.	The research on K-means clustering assistance funds for the Family Hope Program (PKH) revealed that ten village data could be grouped into three clusters: C1 with five village data, C2 with four village data, and C3 with one

No.	Title	Method	Object	Outer	Results
			report to the Department Indragiri Hilir Regency Social Affairs.		village data. This study provides valuable insights for appropriate grouping.

CHAPTER III

RESEARCH METHOD

3.1 Research Object and Subject

This research is focused on developing strategies to assist the government in providing education to MSMEs that have yet to obtain halal certification in the Special Region of Daerah Istimewa Yogyakarta. Only 0.11% of MSMEs in Indonesia have registered for halal certification (Waharini & Purwantini, 2018). Several variables will be used to obtain data, such as demographic data, knowledge, awareness, intention, and accessibility. These data will be utilized to understand the characteristics of MSMEs that have not registered for halal certification.

3.2 Type of Data

3.2.1 Primary Data

The primary data source in this research was obtained by distributing questionnaires to MSME actors in Yogyakarta, especially microbusiness actors in the food sector. The data obtained includes demographic data, knowledge, awareness, intention, and accessibility. This data will be used as the primary dataset for data processing using the Clustering method.

3.2.2 Secondary Data

The secondary data utilized to support the research process were obtained by referencing several scientific journals that address theories relevant to the issues investigated in this study. The research requires theories and references from previous studies that have addressed similar concerns. In addition to scientific journals, reference sources were also derived from various books—references from scientific journals and books support in determining the variables utilized in constructing the questionnaire.

3.3 Data Collecting Method

3.3.1 Study of Literature

Literature studies help obtain several references from scientific journals regarding theories as previously explained. Apart from helping to understand scientific theories, the use of literature studies helps determine several variables used in the questionnaire for the Clustering method.

Several variables are suggestions from researchers to enrich the research results. The following are the variables used in the research:

Table 3. 1 Research Variables

No	Variable	Reference	Description
1.	Knowledge (Prabowo et al., 2015)	Revealing Factors Hindering Halal Certification in East Kalimantan Indonesia	Understanding the requirements and procedures for halal certification is necessary for MSMEs to understand what is needed to obtain this certification. This knowledge includes understanding halal certification, methods and requirements for applying for halal certification, halal ingredients, and compliance with applicable halal standards and regulations.
2.	Awareness (Maksudi, et al., 2023)	Imposition of Administrative Sanctions on Government Officials Who Do Not Implement Decisions of the State Administrative Court	Understanding the significance of halal certification amidst public awareness of halal products encourages MSMEs to acquire this certification, which can increase the competitiveness of MSME halal products in local and global markets.
3.	Interest (Qomariyah, 2023)	<i>Persepsi Pelaku UMKM Terhadap Kepemilikan Sertifikasi Halal Untuk Meningkatkan Daya Saing Produk UMKM Madura</i>	Knowing the interest of the MSMEs in registering for halal certification makes it easier to register those interested in registering halal MSMEs.
4.	Cost (Harbit, 2022)	<i>Faktor- Faktor Yang Mempengaruhi Minat</i>	This variable is useful for finding information regarding MSME

No	Variable	Reference	Description
		<i>Pelaku Usaha Untuk Mengajukan Sertifikasi Halal Produk UMKM di Kota Balikpapan</i>	actors' perceptions of the costs required. This may be one of the obstacles to halal-certified MSMEs needing help to develop.

3.3.2 Observation

Observation is a data collection technique carried out through observation, accompanied by recording conditions or behavior of the target object (Dina et al., 2023). In this research, the Author conducted direct observations of MSMEs in Yogyakarta that do not yet have halal certification.

3.3.3 Questionnaire

The questionnaire was created based on variables obtained through a literature study. It is used as basic data for processing using the clustering method. The questionnaire in this research was given to MSME actors in Yogyakarta to find out their characteristics related to halal certification. The following is the first draft of the questionnaire that will be submitted to respondents as data for carrying out the clustering process.

Table 3. 2 Description of Variables and Indicators for Questionnaire

No	Variable	Indicator
1.	Knowledge (Prabowo et al., 2015)	Have you ever attended training? Do you know the requirements for applying for halal certification? Do you know how to apply for halal certification? Did you know what documents you must have to apply for halal certification? Do you know the difficulties in applying for halal certification and how to overcome them?
2.	Awareness (Maksudi et al., 2023)	Are you aware of the benefits you get from halal certification? Are you aware that products need to have halal certification? Do you guarantee your products are halal? Is halal certification for society?

Do the products sold have to have halal certification?		
<hr/>		
3.	Interest (Qomariyah, 2023)	<p>Are you interested in halal certification?</p> <p>Are you interested in producing halal food and drinks?</p> <p>Do you have plans to make halal food and drinks?</p> <p>Will the relevant parties consistently produce halal food and drinks?</p> <p>How interested are you in conducting halal trading?</p>
4.	Cost (Harbit, 2022)	<p>Do you prioritize increasing your business capital rather than obtaining halal certification?</p> <p>Do you face obstacles in budgeting the costs required for halal certification?</p> <p>Do you feel that costs are a heavy burden for your business?</p> <p>Is the income sufficient to carry out halal certification?</p> <p>Is halal certification expensive?</p>

3.3.4 Interview

An interview is a communication between two or more parties that can be done face-to-face. One party acts as an interviewer and the other party as an interviewee with a specific purpose, for example, to obtain information or collect data. The interviewer asks the interviewer several questions to get answers (Devi et al., 2022). In this study, researchers asked directly about halal certification and its reasons.

3.3.5 Observation

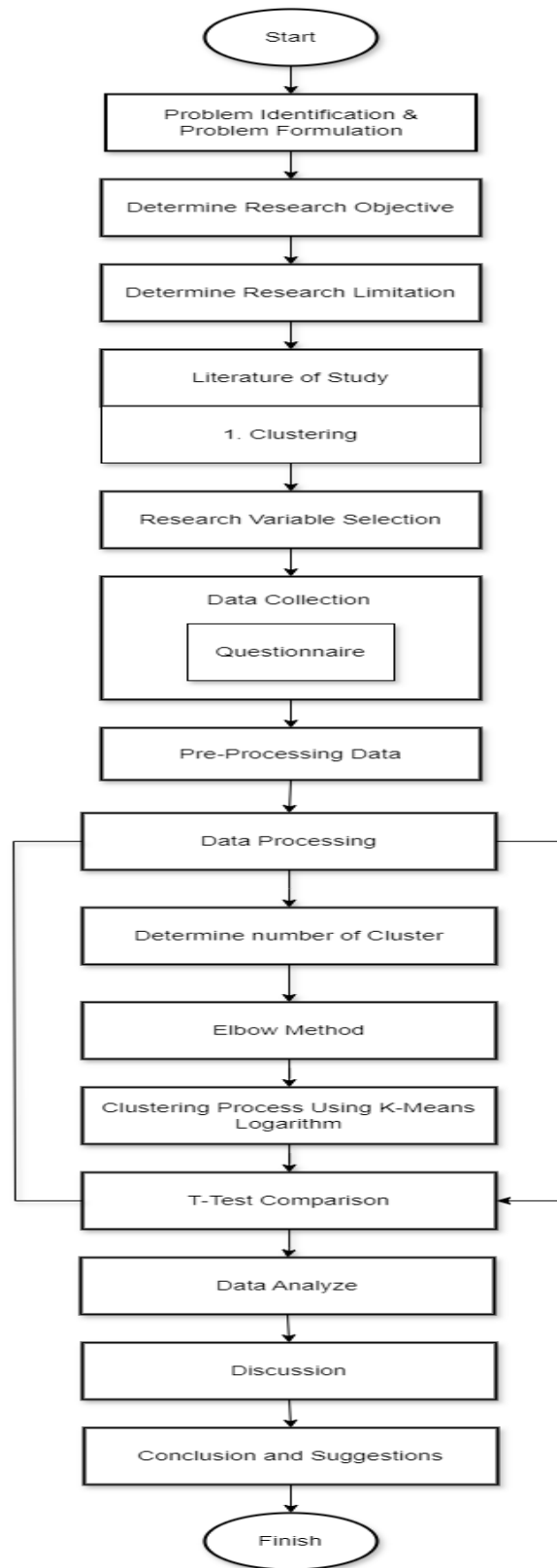
Observation is defined as the direct observation of an object in the environment, whether it is ongoing or still in a stage. It includes various attention activities aimed at studying an object using sensing. Observation is an action carried out intentionally or consciously and in a sequence (Khasanah, 2020).

3.4 Data Analysis Method

3.4.1 Clustering Method Analysis

Clustering divides unlabeled data into distinct classes with little to no supervision. Because of the way they are grouped, objects in the same class differ from each other and share similarities. Another description of clustering as a machine learning component that addresses unsupervised learning has been made (Xie et al., 2020). Clustering analysis is used to identify the character of MSMEs related to halal certification, which is homogeneous for each cluster and is formed based on predetermined variables.

3.5 Research Flowchart



a

Figure 3. 1 Research Flowchart

The explanation of the following research flowchart is as follows:

1. Problem Identification and Problem Formulation

The first stage in this research is to conduct research and look at several data sources to help determine the topic of the problem. When you have obtained the problem topic from the research results and some data, continue with the problem identification process appropriate to the problem topic. At this stage, problem formulation is also carried out based on the results of the problem identification. The method used to help solve the problem is also mentioned in this stage.

2. Determine Research Objective

Of course, the process of problem identification and formulation that has been carried out is equipped with research objectives. Determining research objectives becomes a reference and target for solving a problem that has been described in the previous stage.

3. Determine Research Limitation

Every research project certainly requires a problem definition, which aims to provide clear direction regarding the implementation of the research being carried out. By having problem boundaries, researchers can focus more on solving problems that have been targeted since the beginning of the problem formulation.

4. Literature Study

A literature study was conducted to search for several references through scientific journals regarding problems and previous research.

1) Clustering

Several scientific theories regarding the Clustering method are needed to support the research process because clustering is the method used.

5. Research Variable Selection

Variables were determined through references from several scientific journals that had been done previously. The variables determined are related to things that can influence the characteristics of MSMEs in Yogyakarta.

6. Data Collection

Data collection process tailored to needs to help resolve problems that occur. Data collection in this research used a questionnaire distribution technique.

7. Pre-Processing Data

Of course, in the Data Mining process, a process is needed to clean the data that will be used. Data cleaning is carried out to remove empty, inconsistent, and noisy data. The Data Pre-Processing process is carried out for each result obtained from the Clustering method.

8. Data Processing

Data processing is carried out according to predetermined methods.

1) Determine the Number of Clusters

The process of determining the number of Clusters is carried out using a method obtained from the results of a comparison of 4 methods discussed in the literature study.

2) Elbow Method

This process aims to identify the optimal number of clusters.

3) Clustering Process with K-Means Logarithm

After successfully determining the number of Clusters, carry out the Clustering process using the K-Means algorithm.

4) T-Test Comparison

A T-test comparison is needed if only 2 clusters are formed by looking for the mean difference between the 2 clusters.

9. Data Analyze

The data analysis process provides the results of research that has been carried out. After this analysis, the recommendations will be used to resolve the problem of MSMEs that have not registered for halal certification in Yogyakarta.

10. Discussion

A thorough analysis of the findings from the completed data processing analysis will be covered in this section.

11. Conclusion and Suggestions

Provide conclusions and suggestions to answer previously established objectives and align them with the results of the analysis and discussion.

CHAPTER IV

DATA COLLECTION AND PROCESSING

4.1 Data Collection

In this research, an information series is carried out by immediately identifying numerous characteristics of the society in Yogyakarta through an online questionnaire. This cautiously designed questionnaire consists of questions protecting numerous important variables for analysis. These variables are demography, knowledge, awareness, intention, information access, attitude, interest, cost, and perception. The researcher disseminates this questionnaire by providing a website hyperlink to the respondents, allowing them to access and complete the questionnaire online easily. This direct information series method guarantees vast and inclusive distribution throughout numerous segments of Yogyakarta society, aiming to accumulate representative and comprehensive statistics. Using this approach, researchers attempt to collect accurate and comprehensive records and then analyze them to gain in-depth insight into the characteristics and behavior of the people of Yogyakarta in the context of the research.

4.2 Pre-Processing Data

Pre-processing data is an early step before doing the clustering process. This objective is to produce the optimal data; accordingly, the data will be more accurate. In this research, the pre-processing data is doing the data cleaning and data transformation.

4.2.1 Data Cleaning

Cleaning data is used to delete data that is considered disturbing, noisy, and inconsistent, such as typography and wrong typing format. In this research, the data has been collected from 109 respondents. However, 3 data are not appropriate and are considered disturbing, so it is necessary to delete the data and adjust the wrong writing format, as follows;

Table 4. 1 Data Cleaning 1

Nama UMKM	Kabupaten/kota UMKM	Lama Usaha	Produk UMKM	Jumlah Produk
Dingo Coffee	Sleman	2 Tahun	kopi	Banyak
Soto 40 an	Yogyakarta	2003	Warung soto	Banyak
pecel	Yogyakarta	2 Tahun	pecel	Banyak
Es Kepal Milo Nikmat Ra	Bantul	2 Tahun	Es Kepal Milo	Tunggal
7Rasa Catering	Yogyakarta	10 Tahun	Cake, snack, nasi box, dll	Banyak

Based on the table above, data was collected in 2003 on the business length attribute. This data is different from other data which is written according to the age of the business. This is one of the data that is not uniform, so it is necessary to equalize the writing format.

Table 4. 2 Data Cleaning 2

Apakah UMKM yang dike	Apakah anda tertarik mel	Apakah anda tertarik unt	Apakah anda memiliki rei	Apakah pihak terkait akal	Apakah anda tertarik unt
Ya					
Ya	Ya	Ya	Ya	Ya	Ya
Ya	Ya	Ya	Ya	Ya	Ya
Ya	Ya	Ya	Ya	Ya	Ya
Ya	Ya	Ya	Ya	Ya	Ya
Ya	Ya	Ya	Ya	Ya	Ya
Tidak	Ya	Ya	Ya	Ya	Ya
Tidak	Ya	Ya	Ya	Ya	Ya
Ya	Ya	Ya	Ya	Ya	Ya
Ya	Ya	Ya	Ya	Ya	Ya

The table above shows unfilled values for several attributes. Because everything must be filled in, the empty data is considered non-uniform and needs to be removed.

4.2.2 Data Transformation

Data transformation is a change in data formation, and appropriate data processing is needed. The data will be transformed and consolidated appropriately by doing Operation Aggression. The research's demographic data from the questionnaire is still in the form of nominal data; it will subsequently be transformed into numerical data, as shown in the following table;

Table 4. 3 Data Transformation

Variable	Questionnaire Answer	Nominal
Regency	Yogyakarta	1
	Sleman	2
	Bantul	3
	Gunung Kidul	4
	Kulon Progo	5
Length of Business	< 1 Years	1
	1 - 5 Years	2
	5 - 10 Years	3
	10 - 15 Years	4
	15 - 20 Years	5

Variable	Questionnaire Answer	Nominal
	20 - 25 Years	6
	> 25 Years	7
Number of Product	Single	1
	Many	2
Owner's Age	< 17 Years	1
	17 - 25 Years	2
	25 - 32 Years	3
	32 - 39 Years	4
	39 - 46 Years	5
	>47 Years	6
Gender	Male	1
	Female	2
Last education	Elementary School	1
	Junior High School	2
	Senior High School	3
	Bachelor	4
	No School	5
Income	<500.000	1
	500.000 - 5.000.000	2
	5.000.000 - 10.000.000	3
	10.000.000 - 15.000.000	4
	>15.000.000	5
	>25.000.000	6
	>50.000.000	7
Knowledge	Yes	1
	No	2

Variable	Questionnaire Answer	Nominal
Awareness	Yes	1
	No	2
Interest	Yes	1
	No	2
Cost	Yes	1
	No	2
Access Information	Yes	1
	No	2

4.3 Elbow Method

Using this method, cluster values are chosen and added to create a data model that can be used to identify the optimal cluster. Calculate the SSE (Sum of Square Error) from each cluster value to get a comparison. The K value, a good proxy for the number of clusters, shows the largest difference in SSE values. Below are the stages of calculating the K value in K-Means using the elbow method.

1. Start
2. Initialization of K values
3. Increase the K value
4. Calculate the SSE results for each K value
5. Seeing the SSE results from the K value which has dropped drastically
6. set the K value in the form of an elbow-shape
7. Finish

Below is the result calculation using the Elbow Method using Google Collaboratory.

Table 4. 4 Result of the Elbow Method

Cluster	SSE	Difference SSE
1	473.154	0,000
2	207.971	265.183
3	67.862	140.109
4	57.582	10.280

Cluster	SSE	Difference SSE
5	47.808	9.774
6	40.897	6.911
7	36.156	4.741
8	30.969	5.187
9	27.674	3.295
10	24.554	3.120

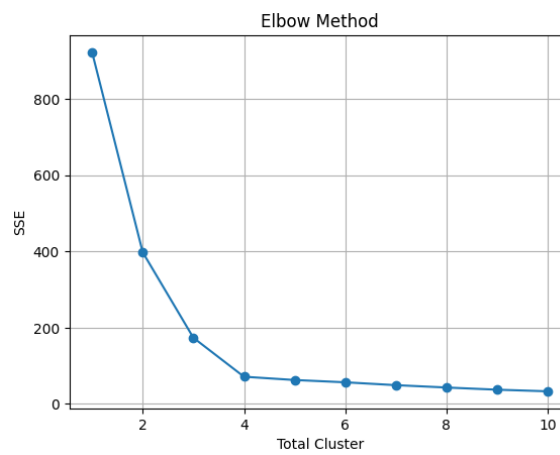


Figure 4. 1 Elbow Graph

Source: Google Colab, 2024

Based on calculation results using the Elbow Method, the largest difference in SSE value is $K = 3$ with a value of 140.109, and on the Elbow Method graph above is the elbow point, which is at coordinate $K = 3$. Then, K-Means cluster calculations can be carried out.

4.4 K-Means Cluster Analysis

In this research, a K-Means cluster analysis process was carried out using SPSS 25 software. The following table shows the calculation of Initial Cluster Centers.

Initial Cluster Centers			
	Cluster		
	1	2	3
Zscore(Regency)	-1.19935	.65658	.65658
Zscore (Length_ff_Business)	.11924	-.58296	2.22585
Zscore (Number_of_Product)	.80626	.80626	.80626
Zscore(Last_Education)	1.12048	-1.87374	-1.87374
Zscore(Income)	2.75859	.65492	-1.44876
Zscore(Knowledge)	-1.80593	.98457	.98457
Zscore(Awareness)	-.78193	3.09116	.76731
Zscore(Cost)	.77801	2.25068	.77801
Zscore(Interest)	-.33292	7.01896	-.33292

Figure 4. 2 Output Initial Cluster Centers

Source: IBM SPSS Statistics 25, 2024

The Initial Cluster Center Output table shows the results of the temporary grouping process carried out before the iteration process is carried out. Then, to detect how many iterations are carried out in this clustering process, the number of 106 data objects can be seen in the image below:

Iteration History ^a			
	Change in Cluster Centers		
Iteration	1	2	3
1	2.642	3.464	3.109
2	.000	.205	.148
3	.000	.088	.067
4	.000	.000	.000

a. Convergence achieved due to no or small change in cluster centers. The maximum absolute coordinate change for any center is .000. The current iteration is 4. The minimum distance between initial centers is 7,048.

Figure 4. 3 Iteration History

Source: IBM SPSS Statistics 25, 2024

The results of the iteration process were carried out with four iterations to determine the correct number of clusters. In this process, it was stated that the minimum distance between cluster centers that occurred from the results of the iteration process was 7,048. After the cluster iteration calculation process, the Final Cluster Centers process is then carried out to form attributes and clusters.

4.5 Analysis of Crosstab Results Using the K-Means Cluster Method

To show the analysis results for each criterion formed using Final Cluster Centers.

Final Cluster Centers			
	Cluster		
	1	2	3
Zscore(Regency)	1.12056	.12349	-.14115
Zscore (Length_of_Business)	-.93406	.05948	-.01627
Zscore (Number_of_Product)	-.21116	-.40599	.34217
Zscore(Last_Education)	-.87567	-.49343	.43759
Zscore(Income)	.12900	-.44168	.35967
Zscore(Cost)	1.68651	.41567	-.40193
Zscore(Knowledge)	.98457	.67584	-.59182
Zscore(Awareness)	2.31654	.38824	-.40141
Zscore (Access_Information)	1.40954	.70048	-.62705
Zscore(Interest)	5.54859	.10507	-.28132

Figure 4. 4 Final Cluster Centers Output

Source: IBM SPSS Statistics 25, 2024

The analysis results for each formed criterion and cluster are displayed in the Final Cluster Centers table. The following guidelines apply to the provisions for interpreting tables from the analysis results in the Final Cluster Centers table:

1. If the calculation results are negative, the cluster with a negative sign is below the average.
2. Furthermore, if the calculation results are positive, the cluster with a positive value is above the total average.

In calculating the average value of each factor in each cluster, use the available general formula.

$$x = \mu + z \cdot \sigma$$

x : sample average (variable in the cluster)

μ : population average

z : standardization value

σ : standard deviation

for example, if you want to know the average regency in cluster 1, namely;

$$x = 2.292 + (-.20442 \cdot 1.07243)$$

$$x = 2.0728$$

So, the average regency in cluster 1 is two or Sleman.

The average cluster attributes can be determined based on the SPSS software results as in the following table:

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Regency	106	1.00	4.00	2.2925	1.07763
Length_of_Business	106	1.00	7.00	2.8302	1.42409
Number_of_Product	106	1.00	2.00	1.6038	.49144
Last_Education	106	1.00	5.00	2.8774	1.00193
Income	106	1.00	5.00	2.3774	.95072
Cost	106	5.000	10.000	6.48113	1.197069
Knowledge	106	5.00	10.00	8.2358	1.79179
Awareness	106	4.00	10.00	6.0094	1.29096
Access_Information	106	5.00	10.00	7.4623	1.80039
Interest	106	5.00	10.00	5.2264	.68010
Valid N (listwise)	106				

Figure 4. 5 Descriptive Statistics Table

Source: IBM SPSS Statistics 25, 2024

The descriptive statistics table in SPSS provides general information about the data being analyzed. By understanding the basic characteristics of the data through these descriptive statistics, we can determine the characteristics of each cluster.

4.6 Cluster Proportion

Number of Cases in each Cluster		
Cluster	1	2.000
	2	47.000
	3	57.000
Valid		106.000
Missing		.000

Figure 4. 6 Number of Cases in each Cluster

Source: IBM SPSS Statistics 25, 2024

The number of cases in each cluster table shows the number of respondents included in each cluster that has been formed. Cluster 1 (2 respondents), cluster 2 (47 respondents), and cluster

3 (57 respondents) with a total of 106 respondents. The researcher called out the layer for the first cluster because the number in the first cluster is very different from clusters 2 and 3.

4.7 Compare Using T-Test Method

Based on the number of each cluster that has been formed, the result of clusters 2 and 3 must be compared using T-Test to find the method to solve the problem of this research is shown below:

Group Statistics					
	Cluster	N	Mean	Std. Deviation	Std. Error Mean
Total_Score	Cluster 2	47	50.0426	4.04302	.58973
	Cluster 3	57	45.7895	3.78784	.50171

Figure 4. 7 Result T-Test Method

Source: IBM SPSS Statistics 25, 2024

Based on the results of the T-Test method, we conclude that the mean of Cluster 3 is significantly lower than that of Cluster 2. Cluster 2 has a higher average total score (50.0426) compared to Cluster 3 (45.7895), indicating that, overall, MSMEs in Cluster 2 tend to have a better total score. Therefore, our focus should be on Cluster 2 to address the issues related to halal certification.

CHAPTER V

DISCUSSION

5.1 Cluster Profile and Labelling

Based on the results of data processing using the K-Means clustering method in the software, it is known that each cluster has a distinct average value. These values represent the characteristics of the cluster's inhabitants, indicating the condition of an MSME based on the predetermined variables. Information on the average value of each cluster is seen in the following table:

Table 5. 1 Profile Each Cluster Result Before T-Test

Attribute	Cluster		
	1	2	3
Regency	Gunung Kidul	Sleman	Sleman
Length of Business	1 - 5 Years	5 - 10 Years	5 - 10 Years
Number of Product	Variety	Single	Variety
Last Education	JHS	JHS	SHS
Income	5.000.000 - 10.000.000	500.000 - 5.000.000	5.000.000 - 10.000.000
Cost	No	Yes	Yes
Knowledge	No	No	Yes
Awareness	No	Yes	Yes
Access Information	No	No	Yes
Interest	No	Yes	Yes

The process of cluster profiling aims to provide valuable, detailed insights into the identity of the cluster's inhabitants. This allows for a clear understanding of the conditions that need to be considered by both MSME managers and government authorities. Further testing is conducted to determine whether there is a significant difference between the potential clusters identified in this study. The results show that there are two potential clusters, while one cluster is considered an outlier due to its small size and significant distance from the others. Below is the profiling of the two clusters, compared using a statistical T-test.

Table 5. 2 Profile Each Cluster Result After T-Test

Attribute	Cluster	
	2	3
Regency	Sleman	Sleman
Length of Business	5 - 10 Years	5 - 10 Years
Number of Product	Single	Variety
Last Education	JHS	SHS
Income	500.000 - 5.000.000	5.000.000 - 10.000.000
Cost	Yes	Yes
Knowledge	No	Yes
Awareness	Yes	Yes
Access Information	No	Yes
Interest	Yes	Yes

The table above is the result of profiling and labeling each cluster that has been formed after conducting the T-Test statistic, the explanation of each cluster is as follows.

1. Cluster 2 (Moderate) consists of SMEs located in Sleman Regency that have been established for around 5-10 years and offer a variety of products. The owners of these SMEs have a background in junior high school education, with an income ranging from 500,000 to 5,000,000. Based on supporting variables, it is noted that they responded Yes to Cost, No to Knowledge, Yes to Awareness, No to Access to Information, and No to Interest.
2. Cluster 3 (Stable) consists of MSMEs located in Sleman Regency that have been established for around 5-10 years and offer a variety of products. The owners of these MSMEs have an educational background in high school (SMA), with an income ranging from 5,000,000 to 10,000,000. Based on supporting variables, they indicated Yes for Cost, Knowledge, Awareness, Access to Information, and Interest.

Based on the explanation of the characteristics of the two potential clusters, it can be observed that the T-test shows a mean difference of 4.2531. This difference is not significantly large, and the characteristics of the two clusters appear to be quite similar. However, some notable differences can be seen in several variables, including the number of products produced by the MSMEs, monthly income, MSME knowledge regarding halal certification, and access to

information about halal certification. This study focuses on understanding the extent of halal certification implementation among MSMEs in Yogyakarta. The data reveals that MSMEs in cluster 2 face limitations in obtaining halal certification for their products, which are often limited to a single product. This may have an impact on their sales revenue (income), which is lower compared to cluster 3.

In the research conducted by Natoen et al., (2018), it was mentioned that there is a categorization of the average income of MSMEs over a one-year period. These categories are below Rp 50,000,000, between Rp 50,000,000 – Rp 250,000,000, between Rp 250,000,000 – Rp 500,000,000, and above Rp 500,000,000. Furthermore, when related to the results of this study, it was found that the members of both clusters fall into the category of MSMEs with middle to lower income levels when converted into a monthly period. It is estimated that the maximum income that can be obtained by these two clusters ranges from Rp 60,000,000 to Rp 120,000,000. Additionally, some findings state the income and management of an MSME are positively influenced by the educational background of its owner. This includes how MSME owners comply with regulations or legalities and their awareness to meet halal certification requirements (Natoen et al., 2018).

5.2 Cluster Analysis and Suggestions

Three clusters have been formed based on the results of cluster profiling and cluster proportions. Cluster 1 is eliminated and becomes the outlier because of the difference in total members. Therefore, it is necessary to carry out the t-test method to compare two objects by measuring the mean of the two clusters to find out which cluster is superior using SPSS software. For further calculations related to the 2 clusters, namely clusters 2 and 3, it is necessary to use the T-Test method by measuring the mean difference between clusters to determine the priority for handling halal certification cases among MSMEs in DIY. These measurements produce cluster 2 with a higher mean than cluster 3, with a concentration on knowledge and access to information which still needs to be improved.

Cluster 2 has problems regarding income range between 500.0000 to 5.000.000; average MSME actors have the latest level of education namely Junior High School, knowledge, and access to information so researchers can provide the following suggestions:

1. Providing guidelines and training to MSMEs managers in Yogyakarta regarding the processes, preparations, and requirements that must be met to apply for halal certification. With the halal certification training, it is hoped that detailed knowledge will be provided, particularly in adapting to the applicable government policies. Therefore, MSMEs managers need to be equipped with the necessary information, such as the documents that need to be prepared, including the Permit License of Micro and Small Businesses, P-IRT documents, and the NPWP of the owner. Equally important is the detailed information regarding the sequential stages that must be undertaken before obtaining the halal certification (Febrimayanti, 2020).
2. Developing a digital portal or mobile-based software application that can be accessed by UMKM actors to obtain information regarding halal certification. This development is essential to facilitate and leverage technological advancements that can incorporate several integrated features, such as online verification or certification services, providing information that assists customers in making decisions about halal products. Additionally, it can enhance automation systems for efficiency and enable real-time data monitoring for related MSMEs. Thus, the design of this application or digital portal will have a positive impact on the government, MSMEs actors, and, most importantly, customers (Nusran et al., 2023).
3. Proposing a collaborative program between the government, non-governmental organizations (NGOs), and the academic sector to empower micro, small, and medium enterprises (MSMEs) by providing guidance and mentoring. The purpose of this program is to help maintain the sustainability of these MSMEs in facing competitive challenges. It could also serve as a starting point for the establishment of new MSMEs, beginning with identifying opportunities, designing strategies, and implementing measures to mitigate operational business risks (Pugu et al., 2024).
4. Providing training related to financial management for SMEs so they can be better prepared and more professional in handling business legality and obtaining the necessary halal certification. In addition, a system of financial incentives, government support, and adequate facilities can be offered to selected SMEs as a form of appreciation for fulfilling halal legality requirements (Mardianto et al., 2023).

Regarding Cluster 3, because issues regarding halal certification with all variables have been fulfilled well, the suggestion is to enhance promotional strategies in visual form using social

media. To develop this capability, MSMEs can receive regular guidance from media content design experts to ensure their promotions effectively capture consumer attention. With the help of media content design experts, it is hoped that MSME players in this cluster can have and develop creative ideas in their marketing. From the cluster results that have been processed, infographic results are obtained as follows:

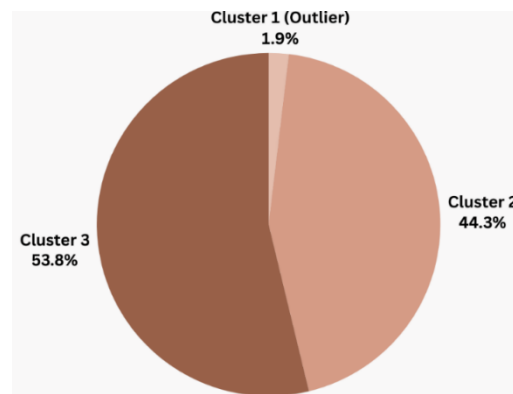


Figure 5. 1 Cluster Profile Infographic

Based on calculating the number of clusters using the elbow method, the largest SSE difference value was obtained, namely 140.109 with the number of clusters $K=3$. Based on cluster analysis using the k-means method, the proportion of clusters with cluster 1 was 1.9% with two respondents, cluster 2 was 44.3% with 47 respondents, and cluster 3 was 53.8% with 57 respondents. The total number of respondents is 106. Below is a summary suggestion for this research, as follows:

Table 5. 3 Summary Suggestion

Program	Training	Develop Technology & Information	Financial support	Mentoring & Strategy Development
Cluster 2	✓	✓	✓	
Cluster 3				✓

Based on Table 5.3 above, each cluster is provided with improvement and development suggestions tailored to their specific characteristics. These suggestions are offered to serve as guidelines for MSMEs in managing their businesses and in meeting essential requirements such as halal certification. Cluster 2 is focused on enhancing the internal aspects of MSMEs through training in various areas, including the implementation of technology. The development of technology is expected to benefit MSMEs by improving financial management and making it

more organized and efficient. Mentoring and monitoring of all aspects of the business are necessary to ensure that challenges are addressed and resolved (Renaningtias et al., 2024).

In addition, adequate financial support is needed to ensure that all the needs and preparations of MSMEs are met. Various forms of financial support can be provided by managers or local governments, such as capital strengthening through loans or subsidies. With financial support, MSMEs can be encouraged, sustained, and helped to maintain their existence, allowing them to run their businesses and meet legal requirements such as halal certification (Asyrafi et al., 2024). Meanwhile, for Cluster 3, MSME owners need to focus on developing marketing strategies for their products. Implementing effective marketing strategies will provide significant advantages for MSMEs, especially when combined with the benefits of having a halal certificate, which can be used as a selling point. The presence of a halal certificate is expected to enhance market positioning and influence customer purchasing decisions (Armiani et al., 2021).

5.3 Research Limitation

This research on the clustering of halal-certified MSMEs in Yogyakarta is an important identification effort to ensure the legality and safety of these businesses, particularly those in the food and beverage sector. There are several limitations in this study, beginning with the limited representation of the sample data results relative to the population of MSMEs in Yogyakarta. The findings may not accurately represent the entire MSME population due to the limited amount of data obtained and processed in this research. This inaccuracy is attributed to the insufficient data available to represent the MSME population and is also influenced by the varying conditions and capabilities of these businesses in meeting certification requirements.

From the perspective of the clustering method used, the study may lose validity if there are discrepancies in the interpretation of the cluster results. Inaccurate interpretations can be influenced by various external factors considered in the analysis of MSMEs within the formed clusters. Additionally, the wide variety of types and levels of MSMEs, which are not uniform in their management and conditions, further complicates the analysis.

CHAPTER VI

CONCLUSION

6.1 Conclusion

The following are the conclusions obtained based on observations, data processing, and discussions in the previous chapter, as follows:

1. Calculating the number of clusters using the elbow method obtained the largest difference in SSE value, 140,109, with the number of clusters being $K=3$. Based on the clustering analysis, the proportion of clusters was obtained, with cluster 1 having two respondents, cluster 2 having 47 respondents, and the last cluster, cluster 3 with 57 respondents.
2. The total number of respondents in this study was 106, but because Cluster 1's characteristics are different from those of Cluster 2 and Cluster 3, it will be an outlier. Further, Cluster 2 (Critical) has respondents who are in the Sleman area and have their last level of education at Junior High School. This will be the focus of this research: guidance and education.
3. Cluster 3 (Stable) has respondents who are in the Sleman area, on average respondents in this cluster have the highest level of education at Senior High School. This affects all variables, based on variable data regarding knowledge, awareness, cost, access information, and interest are high.

6.2 Suggestion

The following are suggestions based on research that has been carried out, as follows.

1. To make data more varied, getting data through more mixed and full ways is suggested.
2. Carrying out direct data collection to determine the characteristics of the area where the data was collected.
3. Apart from that, at the data collection stage, it is recommended to integrate the educational process related to the topic being discussed for MSME players. This approach aims to support MSME actors in providing more detailed information that they may not have known before.

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ATTACHMENT