https://e-journal.upr.ac.id/index.php/jmso
P-ISSN: 2685-4724 | E-ISSN: 2798-9577

AN EVALUATIVE STUDY OF THE OPERATIONAL EFFICACY OF MSME's IN PALANGKA RAYA UTILIZING THE K-MEANS CLUSTERING ALGORITHM

Jonathan Giovanni[1] | Pratiwi Subianto[2]|Alicia Christina Mahar[3] | Fricella Aprianda[4]
[1,3,4]Department of Management, Faculty of Economics and Business, University of Palangka Raya
[2]Department of Development Economics, Faculty of Economics and Business, University of Palangka Raya
Corresponding : jonathangiovanni@feb.upr.ac.id

Abstract
Objective – This study aims to categorize MSMEs in Palangka Raya City based on their performance and competitiveness using the K-Means Clustering methodology.
Design/Methodology/Approach – Data were collected through surveys of 100 MSMEs, focusing on financial performance, product sales, and marketing strategies, and analyzed using KNIME software to create homogeneous clusters.
Findings – The analysis identified three distinct clusters of MSMEs: those with high product diversity, strong financial stability, and emerging MSMEs, each with unique attributes for targeted strategy formulation.
Conclusion and Implications – The study provides strategic recommendations for local governments to enhance MSME competitiveness and foster sustainable economic growth through tailored programs and initiatives.

Keywords: MSMEs, performance, clustering, K-Means, Palangka Raya

INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) are pivotal in fostering economic development within Central Kalimantan (Kalteng). According to statistics from the Central Kalimantan Cooperatives and MSMEs Service, the overall contribution of MSMEs to the Gross Regional Domestic Product (GRDP) of Central Kalimantan was recorded at 43.90% in the year 2021. The count of MSME business units soared to 92,799 in 2021, marking an increase from 64,087 units in the preceding year (Bank Indonesia, 2022). This notable augmentation in the number of business units is undoubtedly a positive development and reflects a burgeoning entrepreneurial spirit within the community. The emergence of new entrepreneurs has beneficial implications for the economy, including enhancements in community welfare and an increase in employment opportunities. Nonetheless, an equally critical aspect of the ongoing MSME development process is the capability of existing MSMEs to evolve their business operations (upgrade) and to further enhance their

Jurnal Manajemen Sains dan Organisasi
Vol. 5, No.3, December 2024
pp. 234 – 243
FEB UPR Publishing
2685-4724

competitiveness in the global marketplace. The substantial contribution of MSMEs to the Central Kalimantan economy presents both opportunities and challenges for stakeholders; should the operational efficiency of MSMEs improve, the economic landscape of Central Kalimantan could be positively transformed. Conversely, neglecting MSME practices could adversely affect income distribution within the community. The crucial presence of MSMEs underscores the necessity for concerted efforts aimed at sustaining and advancing these enterprises, particularly in alignment with contemporary industrial advancements.

Currently, the status of MSMEs in Palangka Raya is progressing, with the retail sector emerging as a promising area for business development. Micro, small, and medium enterprises (MSMEs) serve as a vital indicator of noteworthy advancements in welfare within developing nations. The operational scope of MSMEs constitutes a primary business sector, facilitating labor absorption and contributing to the processes of income equalization and enhancement, whether at the level of Population Income (PN) or Regional Original Income (PAD).

Palangka Raya City harbors considerable prospects for MSME growth. Various distinctive attributes of Palangka Raya, including crafts and manufacturing, are anticipated to achieve national and international competitiveness. However, the practical realities encountered in the field often deviate from these expectations, with numerous MSMEs experiencing a gradual decline in product quality alongside a reduction in the number of operational businesses (Dinas Koperasi dan UMKM, 2023).

Table 1. Development of MSMEs in Palangka Raya City 2018-2022

Year	Number of Units			Total
	Micro	Small	Medium	
2018	5.813	816	81	6.710
2019	6.330	869	91	7.290
2020	6.330	869	91	7.290
2021	8.518	869	91	9.478
2022	8.544	869	91	9.504

The proliferation of micro, small, and medium enterprises (MSMEs) within Palangka Raya City continues to exhibit an encouraging trajectory. In 2022, the rise in MSMEs is predominantly attributed to micro enterprises, comprising a total of 8,544 entities, while the counts of small and medium enterprises have remained constant compared to 2021. This uptick in MSME numbers serves as a favorable indicator for economic advancement, particularly in the context of Palangka Raya City.

MSMEs are integral to the economic landscape of Indonesia; however, their management often lacks optimization, hindering developmental prospects. There is a requisite for proactive engagement from various stakeholders to enhance MSME performance, coupled with a compelling internal motivation within the MSMEs themselves. Several methodologies or alternatives exist to bolster MSME performance, one of which involves the formulation of effective and suitable strategies for MSME development (Rahmanto et al., 2018). The sustainability of MSME performance is contingent upon the adept management of both internal and external factors influencing business growth. Effective management of these factors necessitates the implementation of appropriate strategies (Akhmad et al., 2023).

Each MSME possesses unique characteristics and distinguishing traits, which can vary significantly in aspects such as product development, promotional channels, asset valuation, and

profit margins across different periods. The MSME clustering methodology can be employed to categorize MSMEs exhibiting homogeneity, as discerned through performance and competitiveness metrics. Upon identifying clusters of MSMEs with analogous tendencies, the formulation of tailored strategies for each cluster becomes a more manageable endeavor. The analytic hierarchy process method serves as one viable approach for strategy formulation.

This method involves the establishment of comprehensive priorities based on a ranking system. Multiple stakeholders partake in the ranking determination, with considerations weighted to derive suitable strategies or alternatives for MSME development. Accordingly, this study concentrates on (1) clustering MSMEs in terms of performance and competitiveness, and (2) devising development strategies for MSME clusters utilizing the analytic hierarchy process method.

A significant barrier to progress is the low level of awareness among MSMEs regarding data provision and the suboptimal data collection processes. Poorly integrated data complicates the assessment of MSME requirements. Consequently, this situation impedes the effectiveness of government-initiated programs through relevant agencies, resulting in limited benefits for MSMEs (Sari et al., 2022). The objective of this study is to address the challenges encountered by DinKop-UMKM, specifically by completing MSME data through the distribution of questionnaires featuring indicators that facilitate the identification of appropriate programs for MSMEs, achieved by categorizing them based on performance metrics.

This categorization will subsequently be employed to formulate specific and effective strategies for the development of Micro, Small, and Medium Enterprises (MSMEs). The categorization methodology utilizes the K-Means Clustering technique (Chen & Witten, 2022; Heryati & Herdiansyah, 2020; Marcelina et al., 2023), K-Means Clustering is applicable across diverse data types, encompassing both numerical and categorical data (Abdullah et al., 2022). This versatility facilitates the analysis of MSME data that may encompass various data forms. Furthermore, this investigation incorporates KNIME as a comprehensive tool for data analysis, processing, modeling, and facilitating precise and accessible visualizations of models.

KNIME allows for the seamless transformation, integration, and cleansing of data, and the outcomes of K-Means clustering can be effectively visualized, thereby yielding more holistic insights. The findings of this research are anticipated to make a significant contribution to addressing challenges related to data collection and the advancement of MSMEs in Palangka Raya City. The clustering of MSMEs based on performance metrics can be leveraged for the formulation of efficacious management strategies, thereby enhancing the success rate of MSME enterprises (Wahyudi et al., 2019). Additionally, it is hoped that this will assist the Cooperatives and MSMEs Office of Palangka Raya City in formulating more effective decisions, ultimately resulting in a positive influence on economic development and the enhancement of community welfare in Palangka Raya City.

METHODS

This research employs a cluster analysis methodology with the objective of categorizing various Micro, Small, and Medium Enterprises (MSMEs) within Palangka Raya City. Data is sourced primarily from MSMEs situated in Palangka Raya City and will be systematically transformed into information of substantial significance. The research is structured into four distinct phases, delineated in Figure 1 as follows:

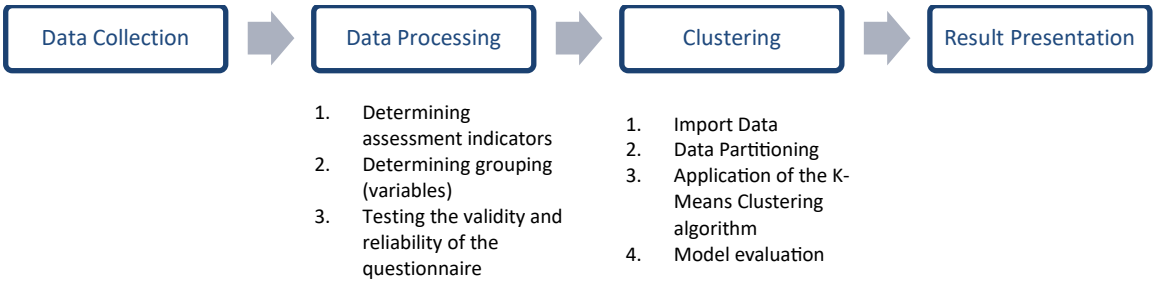

Figure 1. Research Stages

Data Collection

Data processing constitutes the preliminary phase in the research methodology, which holds substantial importance. During this phase, data is amassed through the distribution of online questionnaires. The data collection occurred from August to October 2024 and encompassed diverse aspects of MSME performance that bear significant relevance. To assure the reliability and integrity of the data, the validity and reliability assessment of the performance evaluation questionnaire engaged the participation of 100 individuals who were either MSME proprietors or managers.

Data acquired in this investigation is exceedingly valuable, as it will serve as the foundation for the forthcoming clustering analysis. A meticulous data collection procedure that incorporates various critical elements establishes a robust basis for this study and facilitates the generation of precise and meaningful outcomes, which are instrumental in formulating more effective marketing strategies for MSMEs in Palangka Raya City (Marcelina et al., 2023). To assess MSME performance, the criteria delineated in Table 1 are employed. This table enumerates the assessment indicators utilized to evaluate MSME performance. These indicators encompass various dimensions that are pertinent to the analysis of MSME performance across different sectors (Terttiaavini et al., 2021).

Table 2. MSME Assessment Indicators

No	Indicator	Criteria
1	Education Level	S2 / S3; S1 / K4; D3; D1 / SMA; SMP / SD
2	Business Ownership Status	Individual; Group
3	Business Location Status	Rent; Own; Free Borrow
4	Business Location Address	Business address
5	Business Scale	Micro Business; Small Business; Medium Business
6	Business Type	Various types of businesses in MSMEs
7	Number of Employees	People
8	Monthly Sales Turnover	Total amount of income generated
9	Operational Costs	Costs incurred for daily operational needs.
10	Gross Profit / Profit	Amount of net income after deducting costs
11	Average Production / per Month	Average number of goods produced.
12	Number of Products Sold	Total units of product sold.
13	Buyer Category	Children; Teenage Girls; Teenage Boys; Adults
14	Business Type	Individual; Group
15	Number of Employees	Micro Business; Small Business; Medium Business
16	Sales Method	Total number of people working

According to the criteria established for Micro, Small, and Medium Enterprises (MSMEs), the data has been classified into three principal variables, specifically: 1. Financial Performance, which encompasses the characteristics of Turnover, Operational Costs, and Profit. 2. Product Sales, which includes the metrics of Average Production Volume and Quantity of Products Sold. 3. Marketing Strategy, which incorporates the elements of Business Ownership Status, Type of Business, Employee Count, and Sales Method. This classification of data facilitates a more concentrated examination of the determinants that affect MSME productivity. By delineating these variables into three primary categories, the research can scrutinize each component independently, investigate the interrelations among variables, and discern patterns or trends that may surface (Ahmed et al., 2020; Ghazal, 2021). Consequently, this research can yield a more profound understanding of the factors that impact MSME performance in Palangka Raya City.

Data processing

Data processing encompasses a systematic series of actions aimed at cleansing, structuring, and arranging unrefined data into a format suitable for analytical endeavors (Alexandropoulos et al., 2019). Within the framework of this investigation, data processing entails the preparation of small and medium-sized enterprises (SMEs) performance metrics alongside product quality metrics for the application of clustering analysis via the K-Means Clustering algorithm (Tamba et al., 2019). This procedure is facilitated through the utilization of the KNIME application, a robust tool for data analysis. Employing the K-Means Clustering algorithm enables the categorization of SME performance data and product quality into relevant clusters.

Through the execution of this Data Processing phase, the study guarantees that the data utilized in subsequent analyses is both valid and systematically organized, providing a solid foundation for further processing. The outcomes derived from the cluster analysis will subsequently serve as a cornerstone for pinpointing the elements that impact SME productivity in relation to performance.

RESULTS AND DISCUSSION

This research employs a cluster analysis methodology with the objective of categorizing a selection of Micro, Small, and Medium Enterprises (MSMEs) within the jurisdiction of Palangka Raya City. Primary data has been gathered from MSMEs in Palangka Raya City and is set to be transformed into information of substantial significance. The research comprises four distinct phases, which include data collection, data processing, clustering, and the presentation of findings. At this juncture, the study has successfully completed the first two phases, which entail the collection of data from 100 respondents and the preliminary processing of this data.

Descriptive Test

To assess the efficacy of Micro, Small, and Medium Enterprises (MSMEs), the criteria delineated in Table 1 are employed. This table encapsulates the evaluative metrics utilized to gauge the performance of MSMEs. These metrics encompass a multitude of dimensions pertinent to the analysis of MSME performance across diverse sectors (Marcelina et al., 2023). In accordance with the MSME criteria data, the information has been categorized into three principal variables, specifically: 1. Financial Performance, which encompasses the elements of Turnover, Operating Costs, and Profit. 2. Product Sales, which includes the components of Average Production Volume and Quantity of Products Sold. 3. Marketing Strategy, which entails the factors of Business Ownership Status, Type of Enterprise, Workforce Size, and Sales Approach.

This classification of data facilitates a more concentrated examination of the determinants affecting MSME productivity. By partitioning these variables into three fundamental categories, the research can scrutinize each dimension independently, investigate the interrelations among variables, and discern patterns or trends that may arise (Ahmed et al., 2020; Ghazal, 2021). The compiled data is available in the appendix. The subsequent phase, following data collection, involves the execution of a descriptive analysis. Descriptive analysis is a methodological approach employed to comprehend and encapsulate data in a statistical format that elucidates the primary characteristics of a dataset. Its principal aim is to furnish an overview of the data without inferring conclusions or testing hypotheses. Within the framework of MSME performance, descriptive analysis aspires to elucidate the patterns, distributions, and trends associated with the pertinent variables. This descriptive analysis will examine the variability of MSMEs based on financial, production, and marketing performance.

In general, the financial performance of Micro, Small, and Medium Enterprises (MSMEs) in Palangka Raya City demonstrates a high level of operational cost efficiency alongside commendable profitability. Elevated profit margins exceeding 70% signify proficient financial management practices. The overall sales performance also reflects a commendable status, with a sales ratio approaching 100%. This indicates a robust demand for MSME products coupled with efficient inventory control. Regarding marketing strategies, collective business entities exhibit a competitive edge in marketing relative to individual operators. The integration of both offline and online marketing techniques represents the most efficacious strategy, although a significant proportion of MSMEs have yet to fully embrace this approach.

Model Evaluation

Model evaluation was undertaken to assess the effectiveness of the clustering model for Micro, Small and Medium Enterprises (MSMEs) that was developed utilizing the Predictor Regression node, with the objective of scrutinizing and quantifying the degree to which this clustering model can generate precise predictions or estimations of MSME characteristics. Additionally, the evaluation of the model encompasses the utilization of the cluster validity index to appraise the quality of the resultant cluster.

Based on the analysis conducted through node scores, a Cohen's Kappa score of 0.82 was attained. This score signifies that the predictions rendered by the model align closely with the outcomes derived from actual measurements. Cohen's Kappa scores span from -1 to 1, with values nearing 1 signifying a high level of correlation between predictions and actual results. Positive scores indicate concordance between predictions and empirical observations, whereas negative scores denote discrepancies. An Error value of 0.122 signifies that the mean deviation between the predicted and actual values is approximately 0.122. This error value is represented in percentage terms.

Expressed as a percentage, an Error value of 0.122 corresponds to 12.2%. This suggests that the model exhibits an error rate of roughly 12.2% when estimating the utilized test data. An Accuracy Value of 0.87 demonstrates that the model is capable of delivering correct predictions in approximately 87% of the total cases evaluated. This figure elucidates the extent to which the model successfully differentiates between various classes or categories in its predictions.

Visualization of Results

The data visualization produced within the KNIME platform seeks to elucidate the intricate clustering patterns that arise from the data set following the implementation of the K-Means Clustering algorithm.

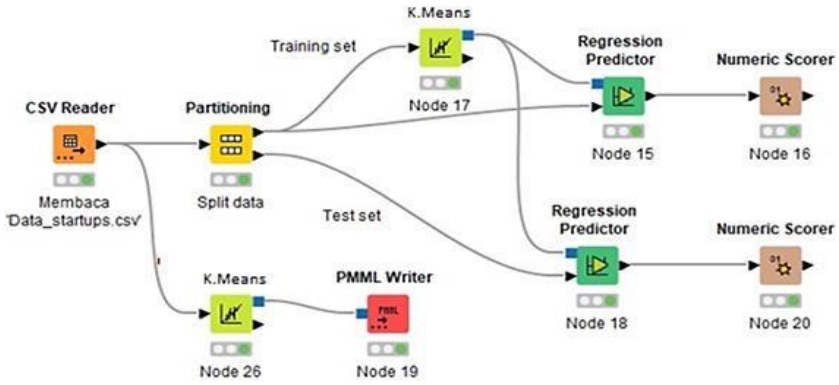

Figure 2. Visualization of KNIME working steps

The outcomes of this analytical process are depicted in the figure below, which offers a thorough representation of the clusters formed and the allocation of data points within each respective cluster. The node employed for the analysis of results in the context of patterns or visual illustrations is designated as the Scatter Plot.

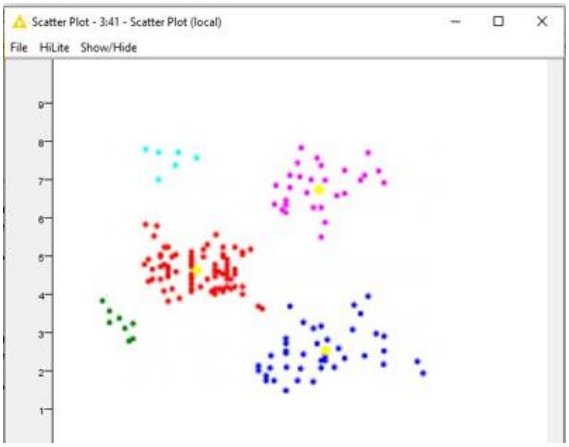

Figure 3. Scatter Plot Visualization

This node enables the visualization of data via scatter plots, thereby augmenting the comprehension of patterns within the data set and elucidating the interconnections among various variables. By employing the Scatter Plot, it becomes possible to swiftly identify data clusters or post-cluster analytical formations, such as those resulting from the K-Means Clustering algorithm illustrated in the subsequent figure. In the visualization exhibited in the Scatter Plot above, the relationship among three critical variables pertinent to micro, small, and medium enterprises (MSMEs)—namely Financial Performance, Product Sales, and Marketing Strategy—is distinguished through the application of distinct colors that correspond to the three cluster categories: MSMEs

characterized by high product diversity, MSMEs exhibiting sound financial stability, and nascent MSMEs.

Small and Medium Enterprises (SMEs) exhibiting a significant variety of products, represented by red markers, are positioned along the X-axis (Financial Performance) with a diverse range of product sales (Giovanni & Subianto, 2023). This phenomenon suggests a propensity among these SMEs to implement multifaceted marketing strategies, as demonstrated by the broader dispersion of data along the Y-axis (Product Sales). This category of SMEs is predominantly defined by the multitude of products they provide. Their adaptability to satisfy the requirements of various market segments constitutes one of their competitive advantages. SMEs within this classification typically exhibit rapid innovation, developing new products that captivate consumers.

The marketing strategies they employ are also varied, encompassing social media, local collaborations, and direct consumer promotions. Nonetheless, the extensive product variety frequently poses difficulties in sustaining quality consistency and brand identity. Furthermore, operational management becomes increasingly intricate due to the necessity of managing inventory across diverse product types. Examples of this cohort include Galeri Moneng, which specializes in traditional crafts such as rattan and woven fabrics, and UD Akselerasi, an innovative manufacturer of chopsticks and wooden souvenirs. Both SMEs are recognized for their creativity yet encounter challenges in upholding quality and efficiency in production.

Conversely, SMEs that exhibit robust financial stability, illustrated by blue markers, reflect a trend of enhancing financial performance, particularly along the X-axis, with product sales demonstrating consistent growth (Giovanni et al., 2023). This trend signifies that these SMEs are inclined to adopt a more focused marketing strategy, as evidenced by the more concentrated distribution of data along the Y-axis. This group portrays a steady and reliable financial trajectory, bolstered by a marketing approach that prioritizes the preservation of existing market share. SMEs within this cluster typically possess a loyal customer base, which serves as a cornerstone of their resilience in navigating market competition. Financial stability enables them to allocate resources towards business development, such as upgrading production facilities or broadening market reach. However, the emphasis on stability may occasionally hinder the pace of product innovation, potentially constraining their expansion into broader markets.

Instances of Micro, Small, and Medium Enterprises (MSMEs) within this particular cluster include Batik Bahalap, recognized for its consistent production of high-quality batik featuring distinct Kalimantan motifs, and Amplang Bahalap, celebrated for its amplang snacks crafted from mackerel. Both entities uphold product excellence; nevertheless, they must remain vigilant regarding innovation to maintain relevance amid an evolving marketplace. Start-up MSMEs, denoted by green dots, typically exhibit heterogeneous financial outcomes, as evidenced by the broader dispersion of data along the X-axis. Their sales figures fluctuate, and they reveal variability in marketing strategies, as indicated by the distribution along the Y-axis. This category encompasses MSMEs that are in nascent stages of development. Frequently, they possess constrained financial resources, resulting in unstable financial performance. However, this cohort benefits from substantial flexibility and an exploratory inclination towards generating new opportunities.

The assortment of products they offer signifies their attempts to capture market interest, although the marketing strategies employed are often suboptimal. This results in a relatively small and inconsistent market share. Illustrative examples of this cluster are Kedai Kopi Meine Welt, which provides local coffee beverages with contemporary flavor variations, and Kerupuk Basah Sambal Raja, which specializes in gourmet foods featuring innovative seasonings. Both demonstrate

significant potential but require support for business stabilization and advancement. This visualization enables the identification of behavioral patterns and characteristics across the three MSME categories, thereby aiding decision-making and strategic planning geared towards fostering MSME growth and sustainability. This research offers a holistic framework for analyzing MSMEs and imparts valuable insights for future development.

CONCLUSION

The results of this investigation indicate that the suggested methodology may be advantageous for the classification of Small and Medium Enterprises (SMEs) according to specific characteristics. A principal conclusion derived from this analysis is that the deployment of the K-Means Clustering algorithm via KNIME fosters a structured approach to data management. This methodology permits the categorization of MSME performance data into interconnected clusters, thus uncovering patterns that may have previously eluded detection. The evaluation of the model utilizing the Regression Predictor node alongside the Numeric Score node provides insights into the degree to which the MSME clustering model can accurately forecast outcomes. The application of data visualization techniques, including Scatter Plot analysis, improves comprehension of the resultant cluster configurations. The outcome of this clustering endeavor resulted in the establishment of three distinct data clusters. This classification acts as a foundational input for the Cooperatives and SMEs Office to formulate more targeted strategic development initiatives.

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