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Characteristic and Distribution Pattern of Small and Medium Metals Industries in Citeureup District, Bogor Regency

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ABSTRACT

The Bogor Regency Government has designated Citeureup Subdistrict as a thematic cluster for leading metal products in Bogor Regency. Small and medium-sized industries will develop more rapidly if they are located in areas with conditions suitable for industrial development. This study aims to analyze the characteristics and distribution patterns of small and medium-sized metal industries in Citeureup Subdistrict, Bogor Regency. Primary data collection was conducted through field observations and validation, interviews, questionnaires, and documentation. Secondary data collection was carried out through literature reviews. The analytical methods used include descriptive analysis to examine characteristics and nearest neighbor analysis to analyze the distribution patterns of small and medium-sized metal industries. The analysis results show that there are 317 small and medium-sized metal industries in Citeureup Subdistrict, spread across four villages, namely Sukahati Village, Pasir Mukti Village, Tarikolot Village, and Gunungsari Village. The products produced are classified into household appliances, medical equipment, automotive components, construction equipment, and other metal products. The marketing reach includes local, regional, and national scales. The results of the nearest neighbor analysis, assisted by ArcGIS 10.8 software, indicate that the spatial distribution of small and medium-sized metal industries in Citeureup Subdistrict follows a clustered pattern, involving a complete range of actors, including the central government, local government, universities, and other associations.

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INTRODUCTION

The Bogor Regency Government in the Regional Medium-Term Development Plan (*RPJMD*) of Bogor Regency Number 4 of 2019, designates Citeureup Subdistrict as a thematic cluster of leading metal product commodities in Bogor Regency (Aminda et al., 2022). The existence of the metal industry in Citeureup Subdistrict has been ongoing since 1980, and has been a driver of the local economy that has continued for several generations. The metal industry is one of the industries with the fourth-highest number of units in Bogor Regency, which shows that the metal industry is able to absorb labor, create jobs, reduce the unemployment rate, expand employment, and provide economic services.

Industrial clustering theory has evolved significantly over the past decades, with seminal contributions from Porter (1990) who emphasized the role of geographic concentration in creating competitive advantages through knowledge spillovers, specialized labor pools, and supplier networks (Giacomin, 2017). Marshall's (1890) earlier work on industrial districts laid the foundation for understanding agglomeration economies, which remain relevant for contemporary cluster analysis. Recent studies have demonstrated that strong clusters are

associated with higher levels of entrepreneurship, innovation, and regional economic performance (Turkina et al., 2019).

However, there remains a significant gap in the literature regarding the spatial distribution patterns of industrial clusters in developing countries, particularly in Indonesia. While extensive research has been conducted on cluster development in developed economies, limited attention has been given to the unique characteristics and spatial dynamics of industrial clusters in emerging markets. Previous studies in Indonesia have focused primarily on qualitative assessments of cluster development, with insufficient quantitative spatial analysis using GIS-based methodologies.

The metal industry in Citeureup Subdistrict is classified as small and medium industries. The metal products produced are not only in the form of decorations or relief work, but many product innovations are made of metal, such as ashtrays, baking sheets, ovens, cake molds, and flower pots (Turkina et al., 2019). Other products produced are medical devices, baking utensils, central air conditioning accessories, cages, automotive accessories, metal tiles, and household appliances. All of these products are 95% made of metal materials (Choudhury et al., 2022). The metal industry in Citeureup Subdistrict has an important role in meeting the needs of metal products in the domestic market while supporting the industrial sector and the local economy (Gitau, 2020).

Law Number 3 of 2014 concerning Industry mandates that the government develop small and medium industrial centers as part of accelerating the spread and equitable distribution of industrial development throughout Indonesia (Vujanovic, 2017). In line with this policy, West Java Regional Regulation Number 8 of 2018 concerning the Industrial Development Plan of West Java Province for 2018-2038 stipulates Bogor Regency as the center of the metal industry and transportation industry. An industrial center is a small unit of an area that has certain characteristics in which there is a production process of a commodity, economic activity that is formed naturally by being supported by means for the development of products or services consisting of a group of micro, small, and medium entrepreneurs. According to Setiawan, the center is a unity of physical functions in the form of land, facilities, institutions, and human resources. Industrial development through industrial centers is considered one of the solutions to increase regional competitiveness (Berawi et al., 2019; Sembiring & Sugiarto, 2024).

Industrial centers grow naturally as traditional activities of the local community where specific locations and products have been established for a long time. Based on comparative advantages, the products produced come from abundant local raw materials and a workforce that has special expertise in making the products produced. Most of the industrial centers are located in rural areas, so the development of industrial centers is not only beneficial for the development of these SMEs but also for the development of villages in Indonesia.

In Indonesia, the term cluster is often also interpreted as an industrial center; both have the same definition. Industrial development through industrial centers is considered one of the efforts to increase regional competitiveness. This policy is considered beneficial because it involves the economic component, the spatial aspect, and the social aspect of economic development. In addition, clusters can also develop not only organically but also because of targeted efforts by policymakers and practitioners. Cluster policies are an effective instrument to encourage regional development through labor absorption, increasing competitiveness, and regional income (Rentkova, 2019).

The designation of Citeureup Subdistrict as a metal industry center is a form of the local government's commitment to industrial development efforts through industrial clustering. Small and medium industries will develop faster if they are located in locations with suitable conditions for industrial development. A suitable location will have a positive impact on the government and industry players. The cluster concept is a regional and cross-sectoral concept. The lack of understanding of the government as a policymaker actually hinders the development of clusters. Research conducted by Rizal & Kastaman stated that the government's efforts to facilitate the development of industrial clusters in 1,111 centers in 2002-2012, 81% failed. The failure is caused by a mistake in understanding the concept of clusters so that there is an error in formulating variables, sectoral mindset, and a one-size-fits-all approach (Tousi, 2024).

The novelty of this research lies in its comprehensive spatial analysis approach using GIS-based nearest neighbor analysis to quantitatively examine the distribution patterns of metal industries in Citeureup Subdistrict (Bharambe et al., 2024; Diallo, 2024). Unlike previous studies that relied primarily on descriptive assessments, this research employs rigorous spatial statistical methods to provide empirical evidence of clustering patterns. Furthermore, this study contributes to the limited body of literature on industrial spatial patterns in Indonesian contexts, offering insights that can inform evidence-based cluster development policies (Setiowati, 2025; Syafarddin, 2025).

Naturally, clusters are unique and have their own characteristics that are different from each other. A variable from the cluster model may not fit elsewhere, and conversely, a variable that does not exist may be the key to moving the cluster elsewhere. Therefore, understanding cluster patterns is one of the approaches recommended and used by a number of scientists in industrial development policymaking. This research aims to: (1) analyze the characteristics of small and medium metal industries in Citeureup Subdistrict; and (2) analyze the distribution pattern of small and medium metal industries in Citeureup Subdistrict.

The benefits of this research are expected to make practical and strategic contributions. For the Bogor Regency Regional Government, the findings of this research can be used as a basis for evaluation and empirical reference in developing cluster development policies that are more targeted, efficient in resource allocation, and effective in strengthening linkages between actors (government, universities, associations, and industry players). For metal SME industry players, mapping distribution patterns and characteristics can increase awareness of the potential for collaboration, resource sharing, and innovation within clusters (Domenech et al., 2019). In addition, for academics and subsequent researchers, this study provides a scalable and replicable spatial analysis method to study similar industrial clusters in other regions, as well as enriching the literature on regional economics and industrial geography in Indonesia (Rizal, 2018).

METHOD

This research employs a mixed-method approach combining quantitative spatial analysis with qualitative descriptive analysis. The study area encompasses Citeureup Subdistrict, Bogor Regency, which has been officially designated as a metal industry cluster by local government policies. Primary data collection was conducted through various methods, namely observation and field validation (ground check), interviews,

questionnaires, and documentation. Stratified random sampling was employed to ensure representative coverage across all four villages in the study area (Sukahati, Pasir Mukti, Tarikolot, and Gunungsari Villages). A total of 317 metal industry units were identified and mapped using GPS coordinates for spatial analysis.

Observations were conducted to identify the villages in Citeureup Subdistrict that have metal industry business units. Semi-structured interviews were conducted with 45 key informants, including industry owners (n=25), local government officials (n=8), university representatives (n=6), and association members (n=6). Interview protocols were designed to capture information on business characteristics, supply chains, marketing networks, and inter-firm relationships.

Furthermore, field validation or ground checks were carried out to determine the distribution of existing metal industry business units. Questionnaire distribution was conducted to determine methods of raw material acquisition and marketing reach. Secondary data were obtained from various related institutions or agencies, libraries, and the internet. These data sources included planning documents, laws and regulations, spatial data (maps and satellite images), books, journals, research reports, and other secondary data in the form of statistical data from the Central Statistics Agency of Bogor Regency.

The analysis techniques used in this study include descriptive analysis and nearest neighbor analysis assisted by ArcGIS software. The descriptive analysis method is an analysis technique used to analyze data by describing the collected data without making general conclusions. The descriptive analysis method is used to analyze the characteristics of the research object, which are described in the form of narratives, tables, graphs, diagrams, photographs, and so on. The criteria for determining the characteristics of the metal industry in this study can be seen in Table 1.

Table 1 Criteria of Characteristics of the Metal Industry

Yes	Aspects	Indicator	Reference
1.	Industrial business units	There is an activity to change raw materials into finished goods or semi-finished goods.	• BPS
2.	Industry classification	• If the business unit has a total workforce of 1-9 people, it is included in the category of small industries • If the business unit has a total workforce of >19 people, it is included in the medium industry category	• Regulation of the Minister of Industry Number 64/M-IND/PER/7/2016 concerning the Amount of Labor and Investment Value for the Classification of Industrial Enterprises
3.	Classification of Produced Products	• Home Appliances • Medical Devices • Automotive Components • Construction Tools • Other Metal Industries	• KBLI • Business plan • West Java Regional Regulation Number 8 of 2018 concerning the Industrial Development Plan of West Java Province for 2018-2038 • Survey Primer

Source: Processed from BPS, Regulation of the Minister of Industry No. 64 of 2016, KBLI, and primary survey (2024)

The *Nearest Neighbor Analysis method* is used to determine the distribution pattern of activities, whether the distribution pattern follows a random, grouped or uniform pattern as indicated by the magnitude of the value of the activity T. The results of this analysis can provide an overview of the tendency of an activity. The T value or the nearest neighbor's dispersal index is obtained using the following formula:

T = Ju/Jh

Information:

T	=	Index of the spread of the nearest neighbor
Ju	=	The measured average distance between a point and its nearest neighboring point
Jh	=	The average distance obtained if all points have a random pattern =1/2√p
P	=	The density of points in each km2 is the number of points (N) divided by the area in km2 (A), so that it becomes (N/A)

The analysis process in this study was assisted by using *Arcgis* software. *The tools* used are the *Average Nearest Neighbor tools* in ArcGIS 10.8 (Figure 1). The final result of this analysis is in the form of an index *(nearest neighbor ratio).* In addition to the index, other parameters evaluated are Z-score and P Value (Figure 3). If the Z-score is insignificant, the index value is meaningful because there is a chance that it will happen randomly. If the p-value is small, it means that it is unlikely (small probability) that the observed spatial pattern is the result of a random process, so the index can reject the null hypothesis.

RESULTS AND DISCUSSION

Characteristics of Small and Medium Metal Industries in Citeureup District

Industry is any form of economic activity that processes raw materials or utilizes industrial resources to be able to produce goods that have added value or higher benefits, including industrial services. Based on the results of field surveys and secondary data analysis, the metal industry in Citeureup District totals 317 (three hundred and seventeen) industrial units spread across 4 (four) villages, namely Sukahati Village, Tarikolot Village, Pasir Mukti Village and Gunungsari Village (Table 2). Sukahati Village has a metal industry of 82 (eighty-two) units spread across Lengo Village and is only concentrated in 1 (one) community unit (RW), namely RW 01. The metal industry in Pasir Mukti Village is spread across 3 (three) different areas, namely Dukuh village, Pasir Angin Village and Rawabogo Village with a total of 97 (ninety-seven) units of metal industry. The metal industry in Tarikolot Village is 43 (forty-three) spread across 2 (two) areas, namely Bojong Village and Babakan Village. The metal industry in Gunungsari Village is 95 (ninety-five) units located in Tonggoh Village and Nyangkokot Village.

Table 2 Distribution of Metal Industry in Citeureup District

No	Village	Quantity (units)	Percentage (%)
1.	Sukahati Village	82	26%
2.	Desa Tarikolot	43	14%
3.	Pasir Mukti Village	97	31%
4.	Gunungsari Village	95	30%
Total Amount		**317**	**100%**

Source: Primary data from field survey results (2024)

Products produced by the metal industry in Citeureup District can be grouped into 5 (five) categories, namely: 1) the household appliances metal industry; 2) medical device metal industry; 3) Construction equipment metal industry; and 4) automotive equipment metal industry; and (5) other metal industries. The household metal industry is an industry that produces equipment that functions to support daily needs and has specific functions and uses (Kementerian Perindustrian Republik Indonesia, 2018). The home appliance metal industry is the most of any other industry. A total of 211 (two hundred and eleven) or 66% of the total metal industry in Citeureup District produce products in the form of household appliances. This industry spreads in the area of Sukahati Village, Pasir Mukti Village, Gunung Sari Village and part of Tarikolot Village.

The medical device metal industry is a metal industry that produces instruments, apparatus, machines or implants that do not contain drugs that are used to prevent, diagnose, cure and alleviate diseases, treat the sick, restore human health and form structures to improve bodily functions. The medical device metal industry in Citeureup District amounted to 37 (thirty-seven) units or as much as 11.7%. This industry is spread in the areas of Pasir Mukti Village, Gunungsari Village and Tarikolot Village. Meanwhile, in Sukahati Village, there is no metal industry for medical devices. The construction metal equipment industry is an industry that focuses on the production, processing and distribution of types of metals used in the construction of structural buildings, frames and roofs (Kementerian Perindustrian Republik Indonesia, 2018). There are 23 (twenty-three) units or as much as 7.3% of the total metal industry in Citeureup District. The construction metal industry is spread in Tarikolot village, Gunungsari Village and Pasir Mukti Village.

The automotive component metal industry is a metal industry that manufactures automotive components according to technical standards, both in the form of OEM components (components for assembly) and aftermarket components (components for repair) produced for two-wheelers and four-wheelers (Kementerian Perindustrian Republik Indonesia, 2018). The automotive component metal industry amounted to 25 units or as much as 7.9%. This industry is spread in the area of Pasir Mukti village, Tarikolot and most of it is in Gunungsari Village. Other metal industries are metal industries that are not included in the previous 4 (four) industries. This industry produces items in the form of garden lights, decorative lights, meubeleair, kitchen sets and bird cages. Other industries amounted to 2 units or as much as 6.6% of the total metal industry in Citeureup District. Other metal industries spread in Pasir Mukti village, Tarikolot Village and Gunungsari Village.

Of the 317 (three hundred and seventeen) metal industries in Citeureup District, there are 313 (three hundred and thirteen) metal industries that have a workforce of > 19 people and as many as 4 (four) metal industries that have a workforce of 19 < people. Based on the Regulation of the Minister of Industry (Kementerian Perindustrian, 2016), regarding the amount of labor and investment value for the classification of industrial businesses, as many as 313 metal industries are included in the classification of small industries and as many as 4 metal industries are included in medium industries and both are included in the classification of small and medium industries.

Table 3 Number of Industries by Type

No	Industry Type	Quantity (units)	Percentage (%)
1.	Metal Industry Household Appliances	211	66,6%
2.	Medical Device Metal Industry	37	11,7%
3.	Metal Industry Construction Equipment	23	7,3%
4.	Automotive Component Metal Industry	25	7,9%
5.	Other Metals Industries	21	6,6%
	Sum	**317**	**100%**

Source: Primary data from field survey results (2024)

Table 4 Classification of Metal Industry in Citeureup District

No	Industry Classification	Quantity (Units)
1.	Small Industry	313
2.	Medium Industries	4
3.	Large Industries	-
	Sum	**317**

Source: Primary data from field survey results (2024)

The main raw materials used in the production process are iron, steel, aluminum, stainless and copper obtained from local distributors in the Citeureup District area. The technology used can be grouped into 2 (two) categories, namely industries that use modern technology and industries that use traditional technology. Modern technology is mostly used by the medical device industry while the rest still use traditional technology in the production process. The widely used marketing chain pattern consists of 4 (four) channels: (1) the products produced are sold to collectors to be subsequently sold to retailers and consumers; (2) the goods produced are sold to retailers and subsequently to consumers; (3) the goods produced are sold to other industries as intermediate materials; and (4) the goods produced are sold to other SMEs to be subsequently sold to collectors and consumers.

The small and medium metal industry in Citeureup District absorbs a workforce of 1,280 (one thousand two hundred and eighty) people with an age range of between 19-60 years. This shows that as many as 1.9% of the population in the 4 (four) villages work in the metal industry. Meanwhile, when compared to the number of male population, as many as 4% of the total male population in the 4 (four) villages work in the metal industry. In addition, based on BPS data (Badan Pusat Statistik, 2023), the number of workers in small and medium industries in Bogor Regency in 2022 is 50,638 people. This shows that around 0.4% of the total workforce of the small and medium industrial sector in Bogor Regency comes from small and medium metal industries in Citeureup District.

Distribution Pattern of Small and Medium Metal Industries in Citeureup District

Based on the results of the Average Nearest Neighbor analysis using ArcGis 10.8 software, the results of the analysis were obtained that the distribution of the metal industry in the Citeureup District area has a ratio of 0.491848 with a Z-Score of -17.335566 and a significance of 0.000. The ratio is in parameters that show that the metal industry in Citeureup District has a spatial pattern in the form of a spatial cluster.

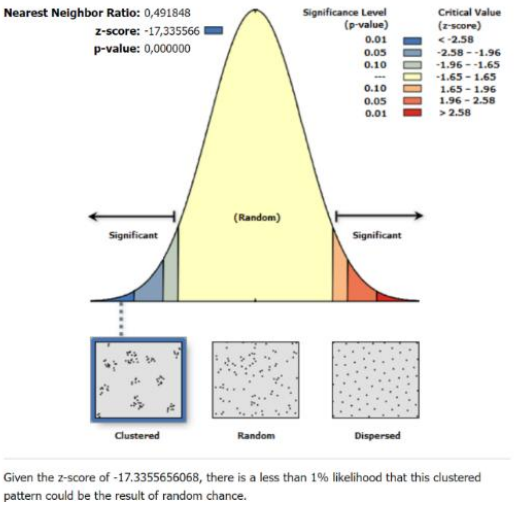


Figure 1. Average Nearest Neighbor Analysis Results

Source: Spatial data processing results using ArcGIS 10.8 (2024)

The results of the above analysis show that small and medium metal industry business units in Citeureup District tend to group and form a cluster.

The existence of small and medium metal industries in Citeureup District that has been going on for a long time is a potential in driving the local economy in Bogor Regency. The uniqueness of this industry lies in its large number and diversity of products produced as well as the involvement of multi-actors. These three points are the keys that must be considered in future development efforts. The spatial pattern of clusters that tend to cluster facilitates the exchange of information, labor and product innovation.

Industrial clusters are basically not just a collection of companies located in a certain location, but also there are linkages both vertically and horizontally, so that existing companies not only compete but also cooperate with each other (Domenech et al., 2019). Experts divide the life cycle of clusters into phases, according to Menzel and Fornahl namely: (1) emergence; (2) growth; (3) maturity; and (4) decline/regeneration. According to Bianchi the life cycle of clusters is: (1) embryo; (2) consolidated; and (3) mature. According to Andersson the life cycle of a cluster consists of 5 (five) phases, namely: (1) agglomeration; (2) emerging; (3) developing; (4) mature; and (5) transformation. Meanwhile, according to Feser, namely: (1) Existing; (2) emerging; and (3) potential. According to research conducted by Saehon and Jaesung, the determinant of the resilience of a cluster is determined by: (1) industrial structure; (2) human resources; (3) government policies; and (4) Location.

The results of the analysis carried out in this study show that there is a compatibility with the Menzel & Fornahl cluster life cycle theory, this theory states that industrial clusters at the embryonic stage are characterized by a larger proportion of the number of industries that are grouped compared to similar industries that are randomly dispersed. The embryo of the cluster can further develop and strengthen the focal point of the cluster which is characterized by the growth of the number of business units, exceeding the growth of business units in the same non-cluster sector. According to Bianchi, Anderson, Menzel & Fornahl, further development is determined through the following criteria: 1) Agglomeration

size; 2) The actors involved; 3) the form of relationships between actors; and 4) Marketing reach.

The first criterion is the size of agglomeration, the emergence of industrial clusters is inseparable from the existence of industrial agglomeration formed by the concentration of production factors (Giacomin, 2017). Experts have different opinions regarding the size of industrial center agglomeration. According to Tambunan & Supratikno, an industrial center is a geographical grouping of at least 20 (twenty) businesses in the manufacturing industry sector that produce more or less the same products. Government Regulation Number 20 of 2024 concerning Industrial Areas (Pemerintah Republik Indonesia, 2024), categorizes SME centers in one location consisting of at least 5 (five) business units that produce similar products, use similar raw materials or carry out the same production process. However, in terms of agglomeration size, the small and medium metal industry in Citeureup District shows a considerable agglomeration of 317 (three hundred and seventeen) units. This amount is a great potential that can be developed into clusters.

The second criterion is the involvement of actors. Actors involved in the metal industry center in Citeureup District consist of the Central Government, Regional Government, universities/research institutions, associations and other institutions. The Central Government involved in the development of the metal industry is the Ministry of Public Works and Public Housing (Ministry of PUPR) and the Ministry of Industry. The involvement of the Ministry of PUPR can be seen from the provision of assistance in the form of the construction of workshops and marketing galleries for 2 (two) villages, namely Pasir Mukti Village and Sukahati Village through the KTAKU Program. Meanwhile, the involvement of the Ministry of Industry can be seen through the provision of machinery for the metal industry in Citeureup District.

The involvement of the local government is carried out by the Housing and Land Office (DPKPP), the Cooperatives and MSMEs Office, and the Community and Village Empowerment Office (DPMD). Local government support is carried out through the provision of assistance and policy support. The involvement of the local government can be seen from the support in the form of machinery grants for Pasir Mukti Villages and Sukahati Villages in 2021, business licensing management in 2021 and training for metal SMEs. Another support is through the issuance of Bogor Regency Regional Regulation Number 1 of 2019 concerning the Empowerment of Cooperatives and Micro Enterprises.

Universities act as think tanks for the metal industry in Citeureup District. The college assists in technical assistance in production, product innovation, business management and product marketing management. The universities involved are the University of Indonesia, IPB University, Pakuan University and Ibn Khaldun University. The involvement of universities is carried out through community service. Some of the activities that have been carried out are: 1) Field Learning Practice (PBL) K3 FKM UI in 2020; 2) Assistance for Metal Craft Business in Pasir Mukti Village in 2021; 3) Village Potential Assistance Activities and the Construction of Village Development Galleries in 2022.

When the research was conducted, there was no association specifically formed by metal business owners in Citeureup District. However, several owners of metal business units in Citeureup District joined the Citeureup District IKM/MSME Forum. This forum was

formed on the initiative of the Bogor Regency Cooperatives and MSMEs Office which aims to accommodate SMEs and MSMEs in every sub-district in Bogor Regency. This forum has a variety of activities such as bazaars, trainings and other activities. Another institution involved is the Dharma Bhakti Astra Foundation (YDBA). YDBA is one of the corporate social responsibility (CSR) implementers of PT Astra Internasional Tbk which was formed in 1980. YDBA is the embodiment of Astra's ideals and philosophy. YDBA strives to encourage MSMEs from traditional industrial centers to modern industrial centers through the Superior Sector Program. By providing training, mentoring, marketing facilitation, and financing facilitation to MSMEs, it is hoped that MSMEs can achieve independence and upgrade and be sustainable. One of YDBA's business development institutions is located in Tarikolot Village with the main core being manufacturing, metal and plastic industry.

The third criterion is the form of relationships between actors in industrial cluster collaboration. According to Handayani et al., the form of relationships between actors in industrial clusters in Indonesia can be seen from; (1) the nature of collaboration; (2) collaboration mechanisms; (3) collaboration strategies; (4) the type of collaboration; (5) the conditions of collaboration; and (6) the condition of the collaborating institution. The nature of collaboration built between stakeholders in the metal industry cluster was initially in the form of mechanical solidarity. In contrast to organic solidarity, this collaboration arises due to similarities in society as actors or owners of the metal industry. Metal industry business owners exchange information about products, raw materials and labor. This solidarity then invites other actors to be involved such as universities, local governments and other actors. If at first the collaboration conditions are based on the principle of mutual trust, then then the actors collaborate by committing to each other, especially to external actors. Likewise with the collaboration mechanism that occurs, if initially the form of collaboration is only limited to market and knowledge sharing, then the collaboration mechanism changes to sub-contracts, R&D and Licenses. The collaboration strategy that was initially operational has now changed to be more strategic. The type of organization is also not only transactional but also coordinated and synchronous. This condition makes the condition of collaborative institutions very dynamic.

The last criterion is the marketing reach, the wider the marketing reach, the greater the chance of cluster development. Marketing reach is classified into local-scale marketing, regional-scale marketing and national-scale marketing. Metal industry products in Citeureup District are marketed on a national scale as much as 20.81%, on a regional scale as much as 48.55% and marketed on a local scale as much as 30.64%.

The diversity of products produced and the use of diverse technologies indicate the existence of industrial structural factors that will play a role in maintaining the resilience of clusters in the face of crises. Clusters will easily restructure when a crisis occurs, this is proven during Covid-19, the metal industry business can adapt by creating products in the form of portable sinks that are in demand by government and private agencies. Various training activities carried out strengthen the resilience of human resource factors. The multi-actor involvement and collaboration that has been built today will further strengthen the cluster growth process in the future. Increased collaboration activities accompanied by awareness from all stakeholders further help the growth of clusters one stage higher. In the

current phase, support needs to be focused on increased collaboration and access accompanied by increased innovation.

Implications for Development Policy

The findings of this study have significant implications for industrial development policy at both local and regional levels. The clustered spatial pattern identified through nearest neighbor analysis suggests that current agglomeration provides a solid foundation for cluster-based development strategies. Based on Porter's diamond model, the concentration of related industries creates opportunities for enhanced competitive advantage through:

1. Factor Conditions: The existing skilled labor pool and specialized supplier networks in the metal industry provide a foundation for further specialization and productivity improvements.
2. Demand Conditions: The diverse product portfolio (household appliances 66.6%, medical devices 11.7%, automotive components 7.9%) indicates sophisticated local demand that can drive innovation.
3. Related and Supporting Industries: The presence of multiple industry categories within the cluster suggests potential for horizontal and vertical linkages that can strengthen the entire value chain.
4. Firm Strategy and Rivalry: The concentration of 317 enterprises within a relatively small geographic area creates competitive dynamics that can spur efficiency and innovation.

SWOT Analysis for Cluster Development

Strengths:
- High concentration of enterprises (317 units) creating critical mass for cluster development
- Diverse product portfolio reducing dependency on single market segments
- Established multi-actor involvement (government, universities, private sector)
- Strong local raw material supply networks
- Skilled workforce with generational expertise

Weaknesses:
- Predominance of traditional technology in production processes
- Limited presence of medium-scale enterprises (only 4 out of 317)
- Fragmented marketing channels with limited collective bargaining power
- Absence of formal industry associations for coordination

Opportunities:
- Government designation as official metal industry cluster provides policy support
- Growing domestic and regional demand for metal products
- Potential for technology upgrading through university partnerships
- Export market development possibilities
- Integration with national supply chains

Threats:
- Competition from other industrial regions with better infrastructure
- Potential raw material price volatility

- Environmental regulations that may affect production processes
- Limited access to formal financing for technology upgrading

Industrial clusters are basically not just a collection of companies located in a certain location, but also there are linkages both vertically and horizontally, so that existing companies not only compete but also cooperate with each other (Domenech et al., 2019). This observation aligns with Krugman's (1991) new economic geography theory, which emphasizes that spatial concentration of economic activities results from the interplay between centripetal forces (such as knowledge spillovers and labor market pooling) and centrifugal forces (such as congestion costs and competition for resources).

CONCLUSION

The metal industry in Citeureup Subdistrict is spread across four villages, namely Sukahati Village, Pasir Mukti Village, Tarikolot Village, and Gunungsari Village. Its main characteristics include being a small and medium industry that produces household appliances, medical devices, automotive component products, construction metal products, and other metal products. This industry absorbs a workforce representing 1.9% of the total population in the four villages and is connected through kinship networks. The results of the nearest neighbor analysis reveal that the metal industry in Citeureup Subdistrict has a clustered spatial pattern with complete involvement of actors both vertically and horizontally. The small and medium metal industry in Citeureup Subdistrict has the potential to be a driver of the local economy that needs to be maintained. The designation of the industrial center by the Bogor Regency Government is an appropriate policy. However, local governments need to optimize the role of stakeholders in the management of small and medium metal industry centers so that all actors are involved completely, serving as one of the levers so that the existing potential can develop more optimally.

REFERENCES

Aminda, R. S., Suharti, T., Rinda, R. K., & Mahmud, K. S. (2022). Quality control and productivity of metal craft products in Pasir Mukti Village, Citeurep District, Bogor Regency. *Abdi Dosen: Jurnal Pengabdian Pada Masyarakat*, *6*(4), 910–933.

Badan Pusat Statistik. (2023). *Statistik Daerah Kabupaten Bogor Tahun 2022*. BPS Kabupaten Bogor.

Berawi, M. A., Susantono, B., Miraj, P., Sari, M., Saroji, G., Berawi, A. R. B., & Sidqi, H. (2019). Accelerating nation competitiveness through economic corridor development: Indonesia masterplan revisited. *International Scientific Conference on Innovations in Digital Economy*, 77–100.

Bharambe, S. N., Mathew, M. S., Khan, M. A., & Deore, R. R. (2024). *GIS & remote sensing: Recent trends and applications*.

Choudhury, M., Bindra, H. S., Singh, K., Singh, A. K., & Nayak, R. (2022). Antimicrobial polymeric composites in consumer goods and healthcare sector: A healthier way to prevent infection. *Polymers for Advanced Technologies*, *33*(7), 1997–2024.

Diallo, B. (2024). *An integrated GI approach for spatio-temporal monitoring and mapping environmental risks under impact of mines extraction* [Doctoral dissertation]. Universidade NOVA de Lisboa.

Domenech, T., Bleischwitz, R., Doranova, A., Panayotopoulos, D., & Roman, L. (2019). Mapping industrial symbiosis development in Europe: Typologies of networks, characteristics, performance and contribution to the circular economy. *Resources, Conservation and Recycling*, *141*, 76–98.

Giacomin, V. (2017). *A historical approach to clustering in emerging economies*. Harvard Business School.

Gitau, J. (2020). *Planning for agro-industries in rural communities: The case of Kinangop Sub-county, Nyandarua County* [Master's thesis]. University of Nairobi.

Kementerian Perindustrian. (2016). *Peraturan Menteri Perindustrian Nomor 64 Tahun 2016 Tentang Besaran Jumlah Tenaga Kerja Dan Nilai Investasi Untuk Klasifikasi Usaha Industri*. Berita Negara Republik Indonesia Tahun 2016 Nomor 1089.

Kementerian Perindustrian Republik Indonesia. (2018). *Profil IKM Logam Di Kecamatan Citeureup Kabupaten Bogor Tahun 2018*. Direktorat Jenderal Industri Kecil dan Menengah.

Pemerintah Republik Indonesia. (2024). *Peraturan Pemerintah Nomor 20 Tahun 2024 Tentang Kawasan Industri*.

Rentkova, K. (2019). The clusters phenomenon and sustainable regional development. *IOP Conference Series: Materials Science and Engineering*, *471*(10), 102039.

Rizal, K. (2018). *Evolving regions: The evolution of regional industries in Indonesia* [Doctoral dissertation]. UCL (University College London).

Sembiring, J. M., & Sugiarto, A. (2024). Implications of the determination of the center for industrial growth on land use in Tanjung Balai City. *Journal of Information Technology, Computer Science and Electrical Engineering*, *1*(3), 278–285.

Setiowati, R. (2025). MSMEs in Jakarta through spatial planning and stakeholder collaboration for sustainability. *APINDO SMEs and Sustainability Journal*, *1*(1).

Syafarddin, S. (2025). Assessment of regional bureaucratic capacity for inclusive economic development policy implementation. *International Journal of Economics and Management Research*, *4*(3), 560–574.

Tousi, S. N. (2024). Clustering policy for urban competitiveness: One-size-fits-all? Evidence from Tehran. *Regional Science Policy & Practice*, *16*(2), 12699.

Turkina, E., Oreshkin, B., & Kali, R. (2019). Regional innovation clusters and firm innovation performance: An interactionist approach. *Regional Studies*, *53*(8), 1193–1206.

Vujanovic, P. (2017). Decentralisation to promote regional development in Indonesia. *OECD Economic Department Working Papers*, *1380*, 0_1.



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