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# Optimizing weaving industry clusters: strategic logistics and growth solutions for competitive regional development

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***Keywords:*** weaving industry clusters, strategic logistics management.
***Abstract:*** This research explores the clustering potential of the weaving industry in South Central Timor District, a sector deeply embedded in cultural heritage with significant economic potential. A qualitative descriptive approach, complemented by spatial analysis using the Average Nearest Neighbor method in ArcGIS 10.5, was employed to identify clustering patterns and assess the feasibility of cluster formation. Of the 1,013 weaving SMEs analyzed, 78 agglomeration centers were identified, encompassing 795 SMEs, with a spatial ratio of 0.060856 and a Z-score of 57.295888, indicating a strong potential for industrial clustering. The paper examines both the opportunities and challenges associated with clustering, particularly in terms of infrastructure development and the need for enhanced collaboration among key stakeholders. It presents a cluster-based development strategy focused on sustainability, cooperation, and market expansion to improve the competitiveness of the weaving industry at local and global levels. The study highlights the critical need for strengthening institutional support, enhancing access to financial resources, and implementing capacity-building programs to improve the entrepreneurial and technical capabilities of artisans. Additionally, fostering partnerships between government bodies, private enterprises, and academic institutions is essential to encourage innovation and knowledge sharing. By adopting an inclusive and well-coordinated cluster development model, the weaving industry in South Central Timor has the potential to achieve sustainable growth while preserving its cultural heritage.

## 1 Introduction

The weaving industry in South Central Timor Regency (TTS), East Nusa Tenggara (NTT), has long been a cornerstone of the region's cultural identity and traditional knowledge. This is in line with [1] that traditional weaving has long been an integral part of Indonesia's cultural heritage. This opinion is also reinforced by [2] that the art of traditional Indonesian weaving has been an inseparable part of the archipelago's cultural wealth for centuries and has become an inseparable part of the lives of the Indonesian people. Various literary sources, including books and journals, indicate that weaving has been present in Indonesia since prehistoric times. Evidence suggests that the tradition of textile weaving has persisted for thousands of years. Weaving skills, passed down through generations, along with distinctive patterns and techniques, have become integral to the area's textile products. However, despite the sector's substantial potential, the weaving industry in TTS faces several obstacles that hinder its growth, especially in the area of market access, financing, and human resource development.

Given the rising global demand for high-quality woven products, both in domestic and international markets, clustering the weaving industry presents a promising strategy to address these challenges. Industrial clustering can foster synergies between key stakeholders, such as industry players, government bodies, educational institutions, and the private sector, thereby improving operational efficiency and overall competitiveness. By forming organized industrial clusters, weaving artisans can optimize the use of resources, improve market access, and integrate advanced technologies. This aligns with the argument [3] that industrial clusters play a pivotal role in

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promoting industrial development and competitiveness, especially when a region is endowed with abundant natural resources.

The opportunity for the weaving industry in TTS lies not only in the potential for an expanding global market but also in the rich cultural traditions that could serve as compelling selling points. However, the development of a robust weaving industry cluster faces significant challenges, including issues related to marketing, financing, and human resource development. Without focused efforts to address these barriers, the full potential of the weaving industry in TTS may remain underdeveloped.

This article seeks to offer a comprehensive analysis of the clustering potential of the weaving industry in South Central Timor, focusing on identifying key opportunities, challenges, and development strategies that can improve the competitiveness of the industry. The insights derived from this study aim to outline concrete steps that can help realize the region's weaving industry potential on a larger, more sustainable scale.

## 2 Materials and methods

This study was carried out in early 2024 in several sub-districts of South Central Timor District, specifically South Mollo, West Amanuban, Batu Putih, and Kokbaun. The research population included weaving industry participants and relevant stakeholders. A targeted sampling approach was used to select respondents who were closely associated aligned with the objectives of the study.

Data gathering comprised either primary or secondary sources. Primary data were collected through interviews, direct observations, and focus group discussions, while secondary data were sourced from official reports and statistical dara. The data were analysed using a descriptive qualitative approach, which enabled a comprehensive understanding of the local conditions, opportunities, and the challenges faced by the weaving industry.

To analyse the clustering of SMEs, the Avenza Map application was used to map their locations, and the Average Nearest Neighbour method in ArcGIS 10.5 was applied to assess the spatial distribution and proximity of these SMEs. This spatial analysis technique is expected to provide valuable insights into the clustering potential and support the development of strategies aimed at strengthening the weaving industry in the region.

## 3 Results

The industrial clustering of weaving SMEs was identified by mapping the distribution of 1,013 SMEs across the South Mollo, West Amanuban, Batu Putih, and Kokbaun sub-districts of South Central Timor District. The proximity of these SMEs was analyzed using the Average Nearest Neighbour technique to assess spatial relationships and identify clustering patterns. The locations of the weaving SMEs, based on the collected data, are shown in Figure 1.

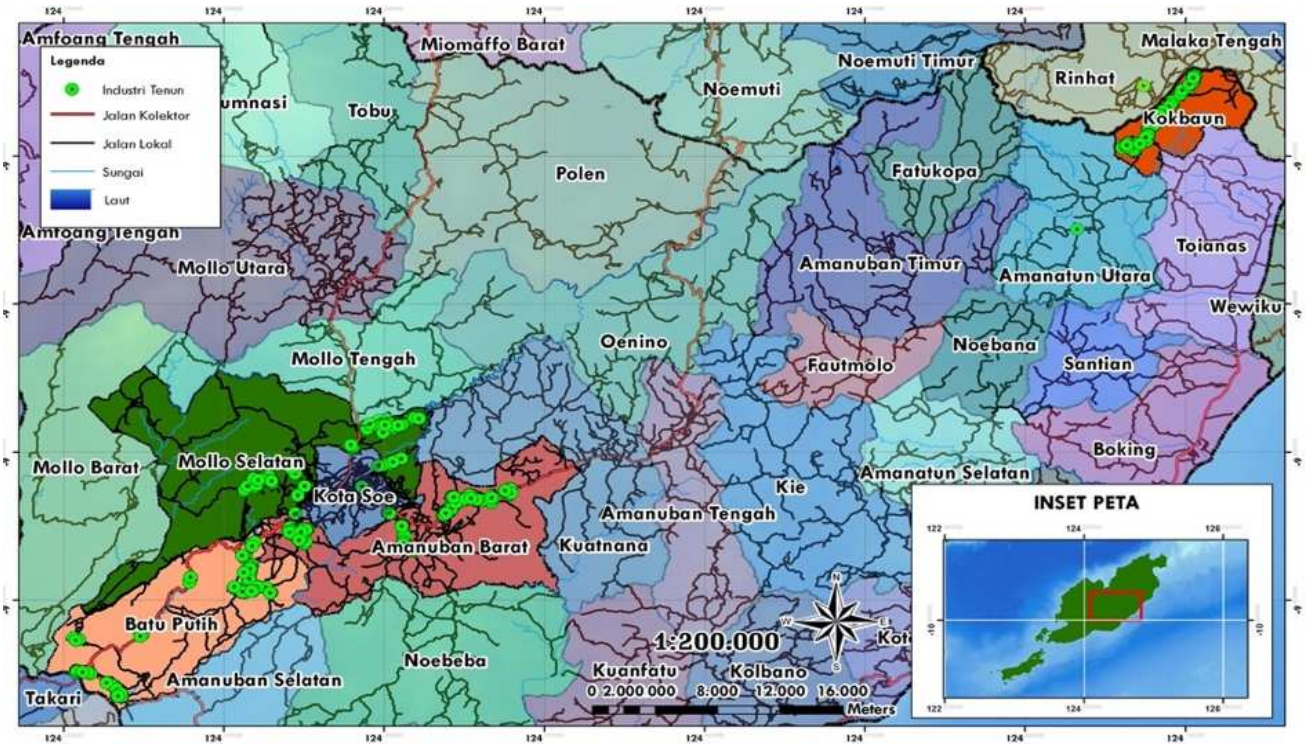


*Figure 1 Map distribution of the weaving industry in South Central Timor, Indonesia*

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The Average Nearest Neighbor analysis conducted using ArcGIS 10.5 reveals that the spatial distribution of weaving SMEs across the four sub-districts has a ratio of 0.060856. With a Z-score of -57.295888 and a significance level of 0.000, the results indicate a statistically significant clustering pattern in the distribution of these SMEs.

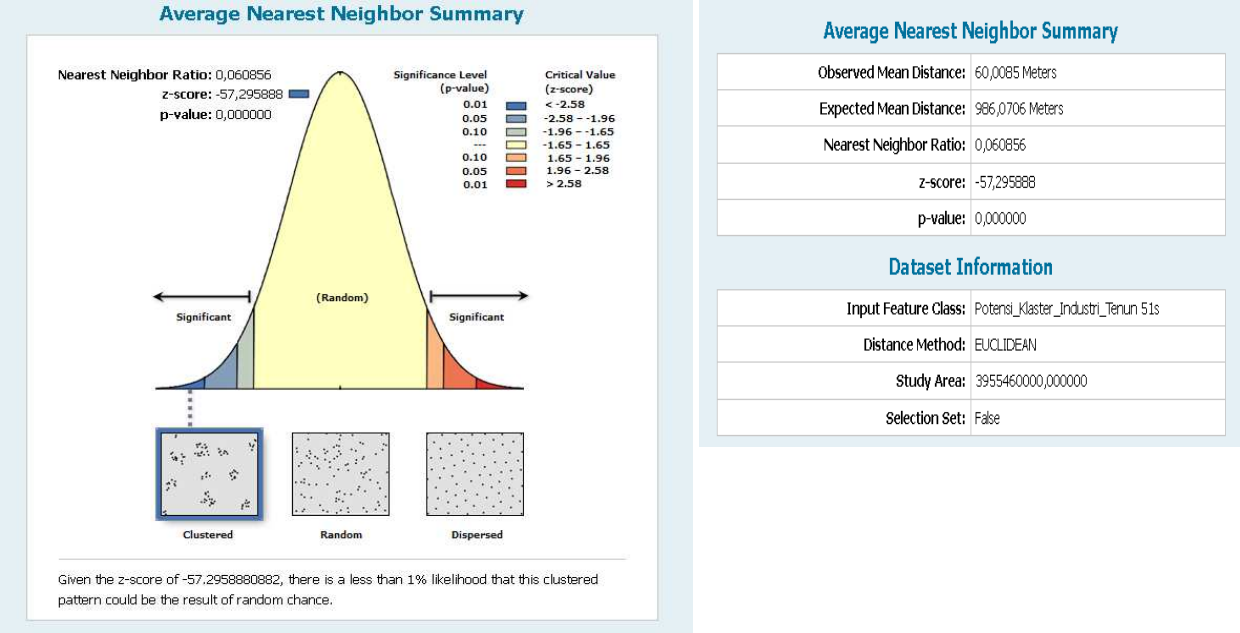


*Figure 2 Results of average nearest neighbour analysis of weaving SMEs*

The distribution analysis of industrial points reveals an average distance of 60.0085 meters between the nearest points. Among the 1,013 weaving SME locations examined, 795 points exhibit the shortest distances, as determined by the Average Nearest Neighbour analysis. This represents 78.55% of the total industrial points, indicating a strong clustering tendency. The results highlight a significant disparity between the clustered distribution and a randomly distributed arrangement of industrial points.

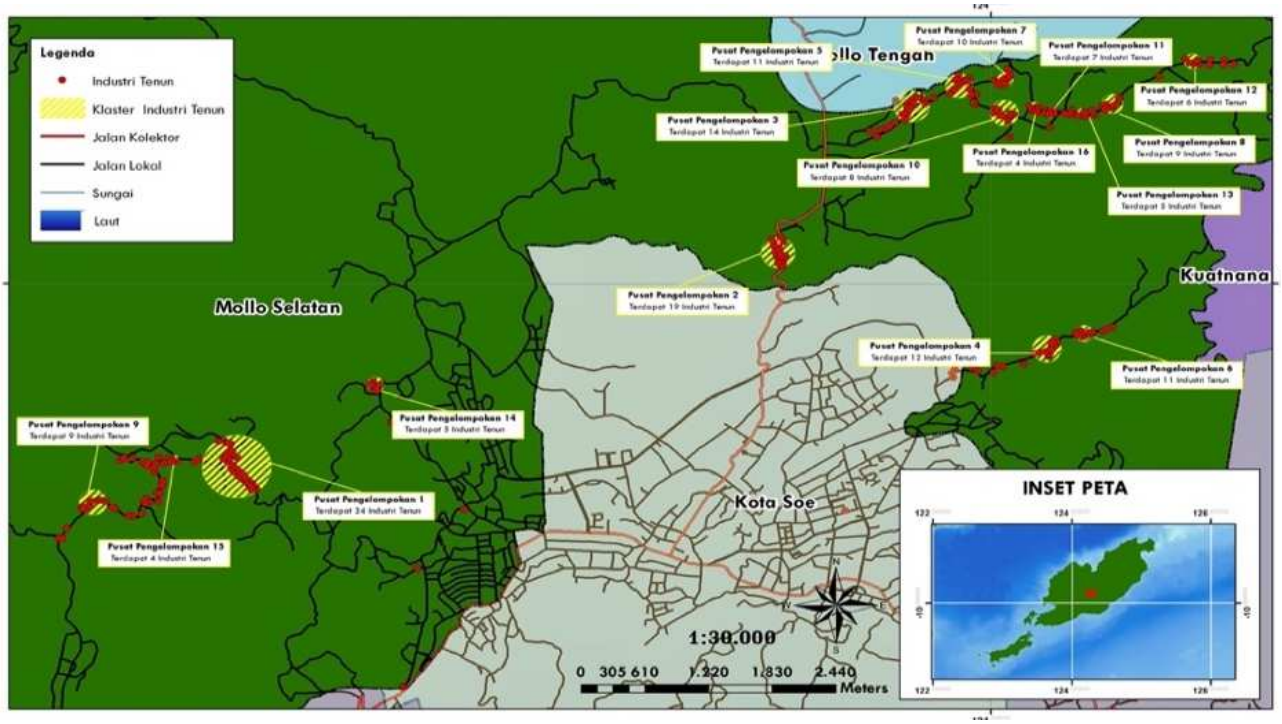


*Figure 3 Clustering of weaving SMEs in South Mollo Sub-district*

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Figure 3 presents the clustering centres of weaving SMEs in the South Mollo sub-district, where 16 centres have formed, accounting for a total of 168 clustered SMEs. Similarly, Figure 4 shows the clustering centres in the West Amanuban sub-district, with 31 centres that aggregate 277 SMEs.

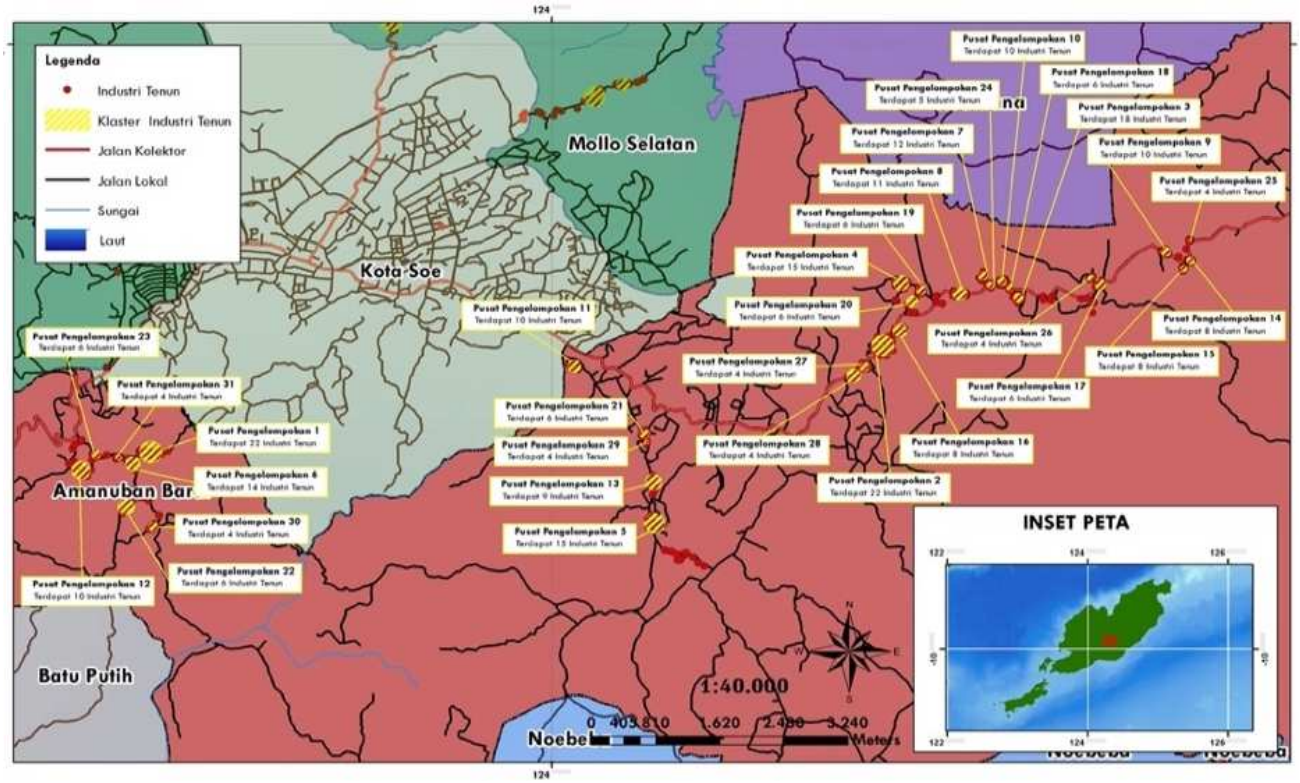


*Figure 4 Clustering of weaving SMEs in West Amanuban Sub-district*

Figures 5 and 6 illustrate the clustering centers of weaving SMEs in the Batu Putih and Kokbaun sub-districts. In the Batu Putih area, 16 clustering centers have been identified, which include 115 agglomerated SMEs. Meanwhile, the Kokbaun area features 15 clustering centers, encompassing a total of 235 agglomerate SMEs.

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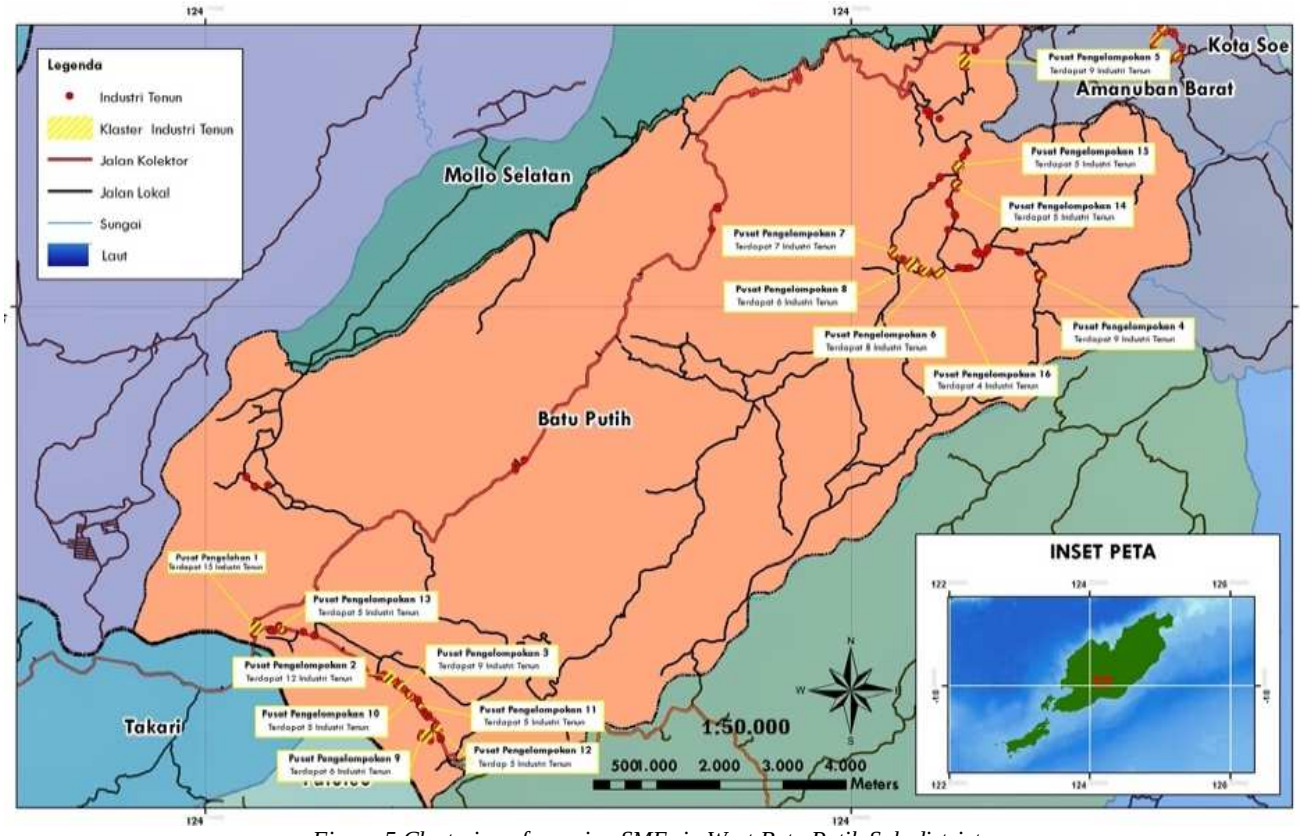


*Figure 5 Clustering of weaving SMEs in West Batu Putih Sub-district*

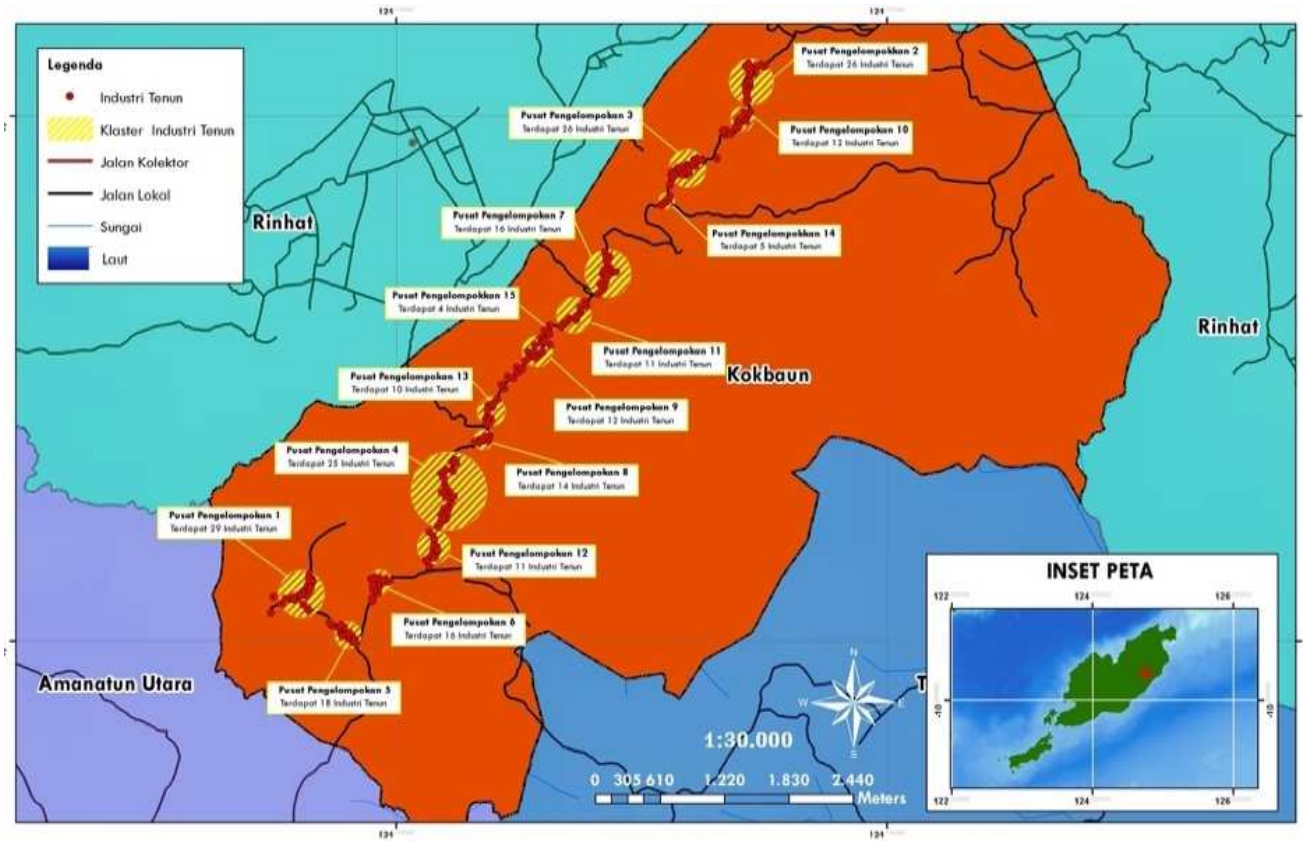


*Figure 6 Clustering of weaving SMEs in West Kokbaun Sub-district*

The nearest neighbor analysis revealed 78 agglomeration centers for weaving SMEs in the region. The evaluation of the agglomeration potential of these SMEs was carried out using the principles of industrial clustering, as outlined below:

1. Agglomeration Size:
   - South Mollo sub-district: 16 clustering centers,
   - West Amanuban sub-district: 31 clustering centers,
   - Batu Putih sub-district: 16 clustering centers,
   - Kokbaun sub-district: 15 clustering centers.

2. Involved Actors:
   - Vertical Relationships: Yarn traders (local market), weaving processors/industries, retailers, and end consumers.
   - Horizontal Relationships: Weaving industry, Office of Industry and Trade of East Nusa Tenggara Province, Office of Trade, Industry, Cooperatives and MSMEs of South Central Timor District, Regional National Craft Council (DEKRANASDA) East Nusa Tenggara Province, Regional National Craft Council (DEKRANASDA) South Central Timor District, and Bank Rakyat Indonesia.

3. Outcomes of Inter-Actor Relationships:
   - Vertical Relationships: The production and distribution flow, starting from raw materials (yarn) to the finished product (woven fabric), which ultimately reaches the final consumer.
   - Horizontal Relationships: Collaborative efforts among institutions and stakeholders to enhance the weaving industry, focusing on production, marketing, and regulatory aspects.

4. Market Reach:
   Woven fabric products are used for daily wear, sold for everyday needs, and are the preferred choice for traditional ceremonies, such as weddings and cultural events. Additionally, these products serve as valuable souvenirs.

The involvement of both vertical and horizontal actors indicates a promising potential for all identified industrial agglomerations. This is further supported by the active engagement of various stakeholders in the industrial ecosystem and government interest. The positive response from provincial and district institutions underscores their commitment to fostering industrial clustering. Moreover, government initiatives, such as the provision of weaving houses, demonstrate tangible efforts to improve production quality and operational efficiency.

## 4 Discussion

The weaving industry in South Central Timor District (TTS), East Nusa Tenggara (NTT), represents a significant pillar of the local economy, functioning as both a crucial source of income for many artisans and a vital component of the region's cultural heritage. The region's distinctive ikat weaving is highly esteemed, especially in the international market, owing to its unique dyeing techniques and intricate designs, which reflect the diverse cultural traditions of the area. However, despite its cultural value, the industry encounters various structural and economic obstacles that impede its full development. Challenges such as limited market access, insufficient financial support, and a dependence on traditional production methods hinder the sector's growth potential. Therefore, establishing a well-organized industrial cluster is crucial for improving production efficiency, expanding market access, and ensuring the long-term sustainability of the industry, all while safeguarding its cultural authenticity. Strategic collaboration among artisans, governmental bodies, and private sector stakeholders presents an opportunity to fully harness the potential of the weaving industry.

### *4.1 Opportunities in weaving industry cluster development*

The principal opportunity for advancing the TTS weaving industry lies in the growing global demand for traditional woven products, which are increasingly regarded not only as artistic items but also as functional and fashion-oriented goods. In recent years, a significant increase has been observed in global demand for products that hold cultural significance and are environmentally sustainable. This trend offers TTS weavers a significant opportunity to position their products in international markets. Additionally, advancements in digital marketing and e-commerce platforms have expanded the ability for TTS weaving products to reach a broader audience, both locally and globally.

Enhancing relationships between artisans and various stakeholders—such as retailers, designers, and financial institutions—can further bolster the capacity of the weaving industry. Establishing industrial clusters would facilitate the sharing of resources and information, enabling artisans to introduce their products to broader markets more efficiently. Strengthening connections between producers and consumers, improving supply chain logistics, and refining distribution mechanisms can enhance production efficiency and market responsiveness.

Furthermore, partnerships with academic institutions and research centers would provide artisans with the tools to innovate through the adoption of new techniques and technologies, thus improving product quality. The formation of cooperative networks among artisans can increase bargaining power when negotiating raw material purchases or engaging with buyers. Moreover, integrating digital platforms and e-commerce strategies will enable artisans to compete effectively in both domestic and international markets. Support from both the government and the private sector through policies, financial support

and infrastructure development will be essential for reinforcing these networks, ensuring the industry's sustainable development [4-6].

### *4.2 Challenges faced*

Despite the significant opportunities, several challenges continue to obstruct the progress of the weaving industry in TTS. One of the most pressing issues is limited market access. Many artisans continue to depend on local markets, and their ability to reach broader national and international markets remains underdeveloped. This is due in large part to the absence of comprehensive marketing networks and insufficient awareness of global market trends. Research indicates that a lack of market networks and understanding of global trends often results in fluctuating or declining revenues for businesses, as they face challenges in attracting new customers or maintaining existing ones. Without a robust marketing strategy, businesses fail to maintain competitiveness, particularly in international markets. To mitigate this issue, artisans must develop comprehensive marketing plans that include market research, product customization, and competitive pricing strategies. Employing data-driven marketing techniques can further optimize campaigns and improve customer engagement, thus ensuring continued business growth [7-10].

Another key challenge is limited access to financing. Many artisans in TTS are unable to secure adequate financial resources, which restricts their ability to expand production capacity and modernize their equipment. The lack of financial support limits artisans' capacity for design innovation and technological improvements, reducing their competitiveness. Additionally, without sufficient capital, artisans are unable to access high-quality raw materials or expand their market reach, thus stifling growth. Financial constraints also prevent artisans from engaging in training programs or adopting new production technologies, limiting their ability to meet the demands of large-scale orders. Without external support from financial institutions or government programs, many artisans remain confined to traditional, small-scale operations and are unable to adapt to the evolving demands of the broader market [11-13].

The quality of human resources also represents a significant barrier to industry growth. While traditional weaving techniques have been passed down through generations, artisans often lack additional training in areas such as business management, marketing, and modern production methods. This absence of skill development hampers both product quality and production efficiency, undermining the industry's competitiveness. Additionally, many artisans are not familiar with modern production technologies, which further limits productivity and cost-effectiveness. The lack of digital literacy also exacerbates the situation, as artisans are unable to leverage e-commerce platforms to expand their market reach. To overcome these challenges, it is crucial to provide comprehensive training programs that address both technical skills and business acumen, allowing artisans to thrive in an increasingly digital and competitive marketplace [14-16].

### *4.3 Weaving industry cluster development strategy*

To address these challenges, several strategic approaches can be implemented to develop the weaving industry cluster in South Central Timor (TTS):

- Improvement of Market Access through Digitalization: Developing a robust digital marketing infrastructure is vital to enhancing market access. The creation of online platforms that allow artisans to sell directly to consumers can bypass traditional market limitations and increase market reach. Additionally, providing digital marketing training will help artisans understand how to effectively target broader audiences. Incorporating secure online payment systems and reliable logistics services will also enhance customer trust and streamline transactions. Collaborations with e-commerce platforms and influencers will help increase product visibility and brand recognition. Additionally, data analytics can assist artisans in understanding consumer preferences and refining their marketing strategies. Government and private sector support in the form of financial incentives or grants for digital transformation will be essential in helping artisans transition successfully to digital markets [17-19].
- Expansion of Financing Access: The establishment of an inclusive financing system is essential for the expansion of the weaving industry. Partnerships with banks, microfinance institutions, and non-bank lenders can provide artisans with the necessary capital to invest in modern equipment and expand production capacity. Financial literacy programs are also crucial to helping artisans manage their funds efficiently and make informed business decisions. Cooperative financing models within artisan communities could offer a sustainable financial support system, while integrating digital financial services, such as mobile banking and crowdfunding platforms, could simplify loan application processes. Government initiatives, such as low-interest loans or grants, could further incentivize artisans to innovate and expand their operations [20-22].
- Comprehensive Skills Development Programs: Providing training programs that cover not only traditional weaving techniques but also business management, design, and marketing is essential for improving both product quality and operational efficiency. Collaboration with academic institutions and designers will allow artisans to access new knowledge and innovative techniques. In addition, digital skills training will enable artisans to leverage online platforms for promotion and sales. Participation in trade fairs, workshops, and exhibitions can help

artisans stay abreast of market trends and consumer preferences. Establishing apprenticeship programs with experienced artisans or professionals in the field can further enhance artisans' expertise. Government and private sector initiatives that support continuous education and professional development will ensure the long-term sustainability of the weaving industry [23-27].

- Adoption of Modern Production Technologies: The introduction of modern production technologies, such as automated looms and eco-friendly dyeing techniques, can significantly improve both production quality and efficiency. Innovation in design that incorporates traditional elements while responding to contemporary market trends can broaden the appeal of TTS woven products. Collaboration with research institutions can help introduce new materials and techniques that improve the durability and sustainability of woven products. Additionally, the use of digital design tools can streamline the production process while maintaining the authenticity of handcrafted textiles. Adopting environmentally friendly production practices, such as using natural dyes, will also appeal to environmentally conscious consumers, providing access to premium markets [28-30].
- Fostering Collaboration Among Stakeholders: Strong cooperation between artisans, government agencies, the private sector, and academic institutions is crucial to developing a thriving and sustainable weaving industry ecosystem. Industry associations or cooperatives can provide a platform for artisans to access funding, advocate for supportive policies, and facilitate knowledge-sharing. Regular forums, workshops, and networking events can strengthen stakeholder relationships and open new avenues for market expansion. Government support in the form of infrastructure development, tax incentives, and export facilitation will be instrumental in stimulating industry growth. Collaboration with universities and research institutions can also drive innovation and research, leading to more efficient production methods and innovative product designs [31-35].

## 5 Conclusion

The weaving industry in South Central Timor has great potential to grow, both economically and culturally. Through strategic industrial cluster organization, existing challenges, such as market access, financing, and the quality of human resources, can be overcome. By capitalizing on existing opportunities and implementing appropriate development strategies, the weaving industry in TTS can become a more competitive and sustainable sector.

Opportunities for clustering the weaving industry in TTS lie in the region's rich cultural heritage, strong community networks, and growing market demand for traditional textiles. By leveraging these strengths, artisans can collaborate more effectively, share resources, and enhance product innovation to meet contemporary consumer preferences. The integration of digital marketing, e-commerce platforms, and environmentally friendly production techniques will further strengthen the industry's resilience and global competitiveness.

However, several challenges must be tackled to guarantee success of industrial clustering. Limited financial access, outdated production methods, and insufficient business and marketing skills remain significant obstacles for many artisans. Resolving these issues necessitates coordinated efforts from the government and the private sector, and educational institutions to provide financial support, infrastructure development, and capacity-building programs. Policies that encourage investment in the weaving industry, promote sustainable production practices, and facilitate access to broader markets will be essential in overcoming these barriers.

To develop a thriving weaving industry cluster, a comprehensive strategy must be implemented. This includes fostering collaboration among artisans and stakeholders, strengthening supply chains, and providing continuous training in modern business practices. Additionally, the establishment of industry associations or cooperatives can help advocate for artisans' rights and enhance their bargaining power. With a well-structured approach, the weaving industry in South Central Timor can transform into a dynamic and sustainable economic sector that preserves cultural heritage while driving regional economic growth.

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