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Hierarchy of Tourist Attractions on Coast of West Kalimantan

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Abstract

Coastal tourist attractions in West Kalimantan differ in importance, facility provision, and development readiness, yet their hierarchy has rarely been examined through road-network connectivity. This study mapped the connectivity of attractions and supporting facilities in Pontianak City, Mempawah Regency, Singkawang City, and Sambas Regency to derive a hierarchy of coastal attractions. Natural attractions, man-made attractions, hotels, restaurants/food establishments, and road-network junctions recorded were treated as nodes, and road connections as links. Hierarchical clustering in UCINET used binary connectivity data and complete linkage, with the cut-off set before the largest increase in linkage distance. This yielded four clusters in each of the four areas. The clusters showed distinct functional profiles, such as culinary, accommodation, heritage, beach, and mangrove. Service-rich clusters in urban and historic cores complemented nature-dominated clusters, which often lacked hotels or restaurants and joined last in Mempawah, Singkawang, and Sambas. A cross-area synthesis suggests Pontianak as the core node, Mempawah as a transition zone, Singkawang as a coastal tourism sub-center, and Sambas as a peripheral zone with potential for border ecotourism. These findings recommend blue-economy-oriented sustainability guidelines: strengthening coastal corridors, adding small-scale, locally managed facilities where they are lacking, and improving inter-regional and cross-border connectivity with Malaysia. These recommendations are planning proposals and were not tested in this study.

Keywords: hierarchy; attractions; coastal; sustainable; West Kalimantan

INTRODUCTION

Background

The coastal area of West Kalimantan contains tourist attractions with different levels of importance, attractiveness, and development readiness. This hierarchy can be understood through the provincial tourism planning framework established in West Kalimantan Provincial Regulation

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No. 3 of 2018 concerning the Regional Tourism Development Master Plan of West Kalimantan Province 2017–2032 (Pemerintah Provinsi Kalimantan Barat, 2018). Under this master plan, coastal attractions such as beaches, small islands, marine panoramas, riverside landscapes, and villages with historical relics are positioned as part of the province's nature-based, marine, and cultural tourism potential. In addition, West Kalimantan Provincial Regulation No. 2 of 2019 concerning the Revised Regional Medium-Term Development Plan of West Kalimantan Province 2018–2023 identifies priority tourism areas within the province (Pemerintah Provinsi Kalimantan Barat, 2019)

This study focuses on coastal tourism attractions in Pontianak City, Mempawah Regency, Singkawang City, and Sambas Regency. Infrastructure and connectivity influence this hierarchy because they affect the ability of visitors to reach and use coastal attractions. However, infrastructure development should be treated as a supporting factor rather than the main determinant of attraction hierarchy. Sustainable tourism development provides an important framework for this classification because it emphasizes a balance between economic benefits, environmental preservation, and socio-cultural integrity (Gajdošík et al., 2018; Gupta et al., 2024). In the context of coastal West Kalimantan, the blue and green economy supports the sustainable management of marine resources, rivers, forests, urban parks, and green open spaces, thereby helping to maintain the long-term attractiveness and carrying capacity of coastal destinations.

Based on the issues and descriptions above, this research aims to identify the distribution of coastal tourist attractions in West Kalimantan, map their connectivity, analyze the linkages and integration among tourism elements, and examine the resulting hierarchy of attractions. In this study, the nodes of the tourism network consist of natural tourist attractions, hotels, restaurants/food establishment and man-made tourist attractions. The linkages between these nodes are examined through their connectivity within the road network, which reflects the degree to which attractions and supporting facilities are integrated into the coastal tourism system. By analyzing the relationships among natural attractions, hotel, restaurant/food establishments and man-made attractions, this research seeks to classify coastal tourist attractions according to their attraction characteristics, facility provision, and network connectivity. The resulting hierarchical concept of tourist destinations and attractions is then used to identify primary and supporting coastal destinations and to formulate sustainability-oriented guidelines for tourism development in West Kalimantan.



Figure 1. Study Area
(Source: Author, 2025)

LITERATURE REVIEW

Tourist attractions within a region differ in their role, ranging from primary destinations that draw visitors to supporting destinations that complement them, and this differentiation can be understood as a hierarchy. Classical spatial theory explains such differentiation through the arrangement of settlements by the level and range of the services they provide (Christaller, 1966) and through cores that organize dependent peripheries (Friedmann, 1966) , and tourism scholarship has long viewed tourist regions as attractions linked to services and transportation

(Gunn, 1972). Hierarchy can be read in a functional sense, as the relative importance of a node in the tourism system, and in a structural sense, as nested groupings of elements that merge at successive levels of similarity. Pan et al. (2025) , for example, stratified attractions in Shanxi into core, sub-core, sub-edge, and edge nodes based on combined centrality measures, and found that core nodes were either central attractions with a strong ability to draw tourists or transit and distribution centers in the transportation network.

Accessibility is a central explanation for such positions: a network can be modelled as nodes linked by lines that describe the condition of a region connected by facilities and infrastructure (Sun et al., 2015) , the flow of people, goods, and services increases with the level of connectivity (Muazir et al., 2024), and geographic proximity among attractions can improve efficiency in reaching, managing, and promoting them (Damayanti & Suprihardjo, 2016) Empirical evidence points in the same direction, as nature-dominated clusters in Shanxi were relatively inaccessible with poorer facilities, so their connections concentrated within the cluster and few tourists transited through them (Pan et al., 2025) Network analysis offers a way to examine these relations, because representing attractions as nodes and their connections as links can reveal the relative importance of destinations within a tourism system (Ding et al., 2024; Ma et al., 2024), while clustering can identify spatial groupings of tourism activity that inform infrastructure development and visitor-flow management (Shi & Pun-Cheng, 2019).

Two studies published in this journal show complementary ways of reading tourism space, although their settings differ from a coastal corridor. Sugiarti et al. (2020) used GIS mapping with interviews and observation to examine a single historic anchor, Van den Bosch Fortress in Ngawi, and distinguished internal management of the site from external management of its links to the town square, traditional market, rivers, and tourism facilities. They found that this interconnectivity had not yet been applied in developing the tourism package. Their argument is that an attraction cannot be managed in isolation from the services around it. That argument was developed for one anchor attraction at the scale of a town and was supported mainly by descriptive spatial and qualitative evidence. (Rahmatin & Nawangsari, 2025) approached sustainability from the governance side in the Ijen UNESCO Global Geopark, a protected area spanning two regencies. Using field observation, stakeholder interviews, and policy documents, they reported management that remains largely top-down, with limited participatory planning, community involvement, and entrepreneurship development, as well as inconsistent implementation of national tourism and geopark regulations. Together, these studies suggest that tourism structure has a spatial dimension (how attractions and services connect) and an institutional dimension (who manages and benefits), and that neither is captured by the other.

However, most network-based work builds links from tourist movement data and examines one province or city at a time. Spatial-management studies, in turn, tend to focus on a single anchor attraction, and governance studies on a single protected area. Studies that use road-network connectivity among attractions, hotels, and restaurants to structure a coastal corridor appear limited. This study addresses that gap by clustering the connectivity of attractions and facilities in four coastal areas of West Kalimantan and interpreting the resulting groupings as a hierarchy. The studies above are used to interpret what that hierarchy implies for spatial management and governance, not to alter the analytical design.

METHOD

The hierarchical clustering analysis approach was employed using UCINET to examine the spatial organization and

hierarchy of coastal tourist attractions. Natural tourist attractions, hotels, restaurants/food establishments, and man-made tourist attractions were conceptualized as nodes, while road connections between these locations were represented as links. Unlike approaches that rely solely on physical distance, this study measures accessibility through the connectivity between nodes in the road network.

UCINET was used to analyze the linkages among natural attractions, hotels, restaurants/food establishment, and man-made attractions in Pontianak City, Mempawah Regency, Singkawang City, and Sambas Regency. The resulting network structure provides a basis for classifying coastal tourist attractions into primary and supporting destinations according to their attraction type, availability of hotels and restaurants, and level of road-network connectivity. Bengkayang Regency is excluded because its tourism characteristics are more oriented toward inland nature-based and border-area attractions, whereas this study focuses on the coastal tourism corridor of western West Kalimantan. Limiting the analysis to Pontianak, Mempawah, Singkawang, and Sambas therefore ensures greater consistency in the unit of analysis and allows a more focused examination of attraction type, hotel and restaurant provision, and road-network connectivity. Accordingly, hierarchical clustering provides an analytical basis for constructing the hierarchy of tourist attractions on the coast of West Kalimantan. The data consisted of the type of tourist attraction, the availability of hotels and restaurants, and road-network connectivity among attractions and supporting facilities. Data verification and hierarchical clustering analysis using single, complete, and average linkage methods were then performed.

Therefore, the dendrogram-based clustering and hierarchy generated through UCINET support the identification of primary and supporting coastal tourist attractions in each study area and provide a foundation for tourism development planning. The hierarchical clustering analysis was conducted using UCINET based on binary connectivity data among nodes. The linkage distance in the resulting dendrogram represents the dissimilarity of connectivity patterns among natural attractions, hotels, restaurants/food establishment and man-made attractions, rather than physical distance or road length. Nodes were grouped into clusters according to the similarity of their connections within the road network.

Decisions regarding merging or splitting in hierarchical grouping were considered based on the linkage criterion, which defined the measurement of the distance or similarity between clusters. Commonly used linkage criteria were Single (the minimum distance between nodes in two clusters), Complete (the maximum distance between nodes in two clusters) and Average (the average distance between nodes in two clusters (Pitafi et al., 2023). Single linkage, also known as the nearest-neighbor method, defines the distance between two clusters as the shortest distance between any two nodes in the cluster. In contrast, complete linkage uses the longest distance between any two points in a cluster as an inter-cluster distance. Average linkage calculates the average distance between all pairs of nodes in two clusters.

Complete linkage (maximum linkage) was selected as the primary linkage method for the hierarchical clustering analysis. This method joins clusters based on the maximum distance between members of different clusters, thereby producing more compact and internally coherent clusters. Complete linkage was considered appropriate because the study aims to group coastal tourist attractions according to similarities in attraction type, hotel and restaurant availability, and road-network connectivity. By requiring all members of a cluster to be relatively similar, complete linkage reduces the risk of combining attractions that have only one weak connection but differ substantially in their overall characteristics.

The number of clusters was determined by examining the complete linkage dendrogram generated in UCINET. The cut-off point was selected at the level before the largest increase in linkage distance. This criterion was used to balance cluster detail and interpretability: a lower cut-off would produce excessive fragmentation and many small clusters, whereas a higher cut-off would merge clusters with substantially different characteristics.

The hierarchical clustering results were interpreted by examining the dendrogram or tree diagram. Cluster membership and linkage distances were examined to identify the level of association, in terms of similarity or dissimilarity, among nodes within each cluster. The result of this stage was a hierarchical grouping of tourist attractions and destinations in the coastal area of West Kalimantan. A synthesis was then conducted to generate development ideas and indications based on the hierarchical clustering results and changes in the existing road-network structure.

RESULTS AND DISCUSSION

Analysis and discussion of each tourist destination in coastal area of West Kalimantan, including Pontianak City, Mempawah Regency, Singkawang City, and Sambas Regency, are presented as follows.

Analysis of Road-Network Connectivity and Hierarchical Clustering of Pontianak City

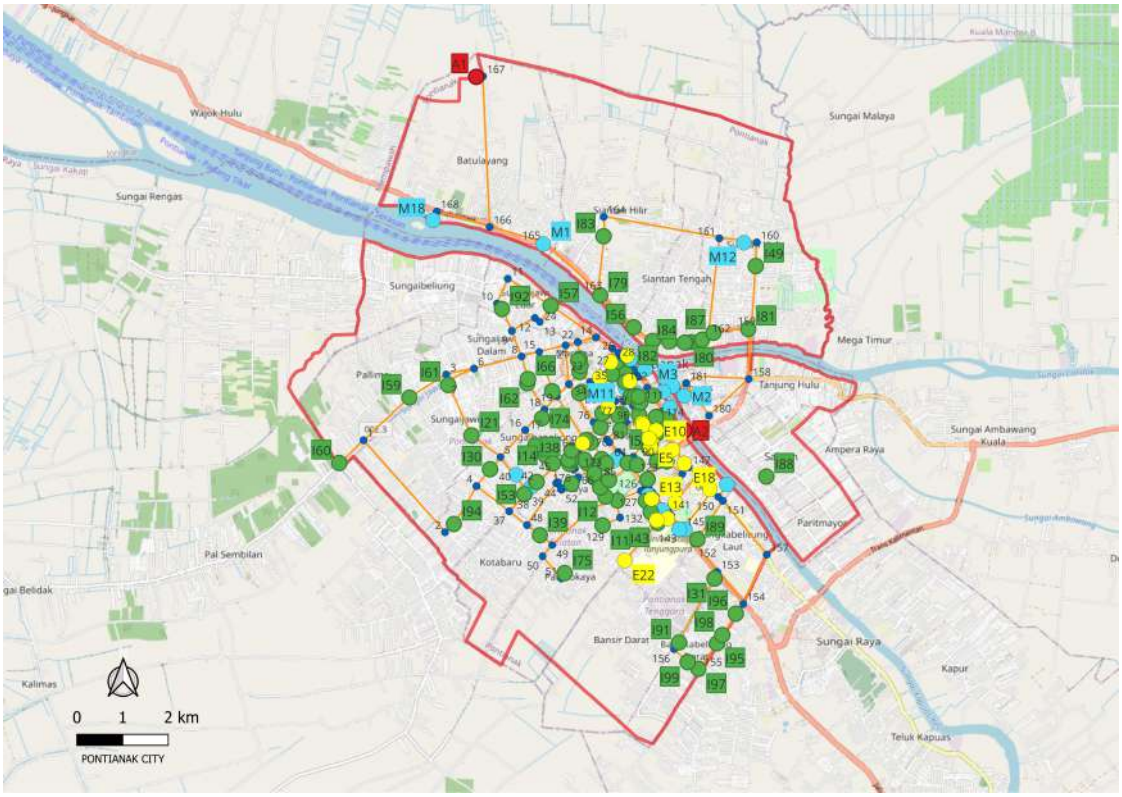


Figure 2. Distribution of Nodes, Natural Tourist Attractions, Hotel Facilities, Restaurant/Food Establishment Facilities, and Man-Made Tourist Attractions in Pontianak City (Source: Author, 2025)

Figure 2 illustrates the spatial distribution of tourism-related elements in Pontianak, comprising 2 natural tourist attractions (Code 'A'), 23 hotel facilities (Code 'E'), 98 restaurant/food establishment facilities (Code 'I'), 21 man-made tourist attractions (Code 'M'), and 182 road-network nodes (Code with number). Total

number of nodes 327. These code color categories facilitate the identification of the spatial distribution and connectivity patterns among tourism attractions and supporting facilities within the road network.

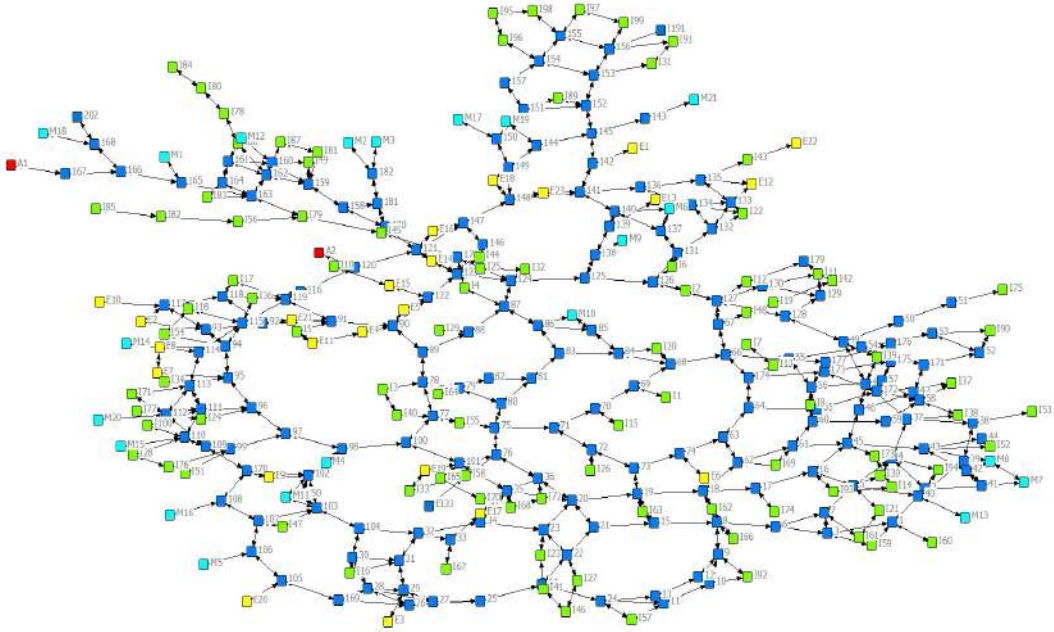


Figure 3. Nodes Between Road Networks, Natural Tourist Attractions, Hotel Facilities, Restaurant/Food Establishment Facilities, and Man-Made Tourist Attractions in Pontianak City (Source: Author, 2025)

Based on Figure 3 shows the network generated in UCINET. Natural attractions are coded in red with the prefix 'A', hotels in yellow ('E'), restaurants/food establishments in green ('I'), and man-made attractions in light blue ('M'). Road network nodes are shown in blue and numbered 1-182.



Figure 4. Hierarchical Cluster Dendrogram of Pontianak City (Source: Author, 2025)

Based on hierarchical clustering in UCINET, a dendrogram was generated for Pontianak City, comprising 98 levels and 327 node total derived from a combination of the road network and various tourism elements. The Pontianak City dendrogram appears more open than those of the other areas: many branches extend a long way before joining a group, and merging occurs at relatively large distances. Nodes are merged using complete linkage, so the horizontal position of each junction indicates the distance at which two groups join, and shorter branches indicate nodes with more similar connectivity patterns.

The dashed cut-off line separates the tree into four clusters, which are colored and numbered along the left and right edges. The four clusters showed the connectivity between road nodes (number coding 1-182) and natural tourist attractions ('A'), Hotel Facilities ('E'), Restaurant/Eating Place Facilities ('I'), and man-made attractions ('M'). The functional composition of each cluster is shown separately in Figure 5.

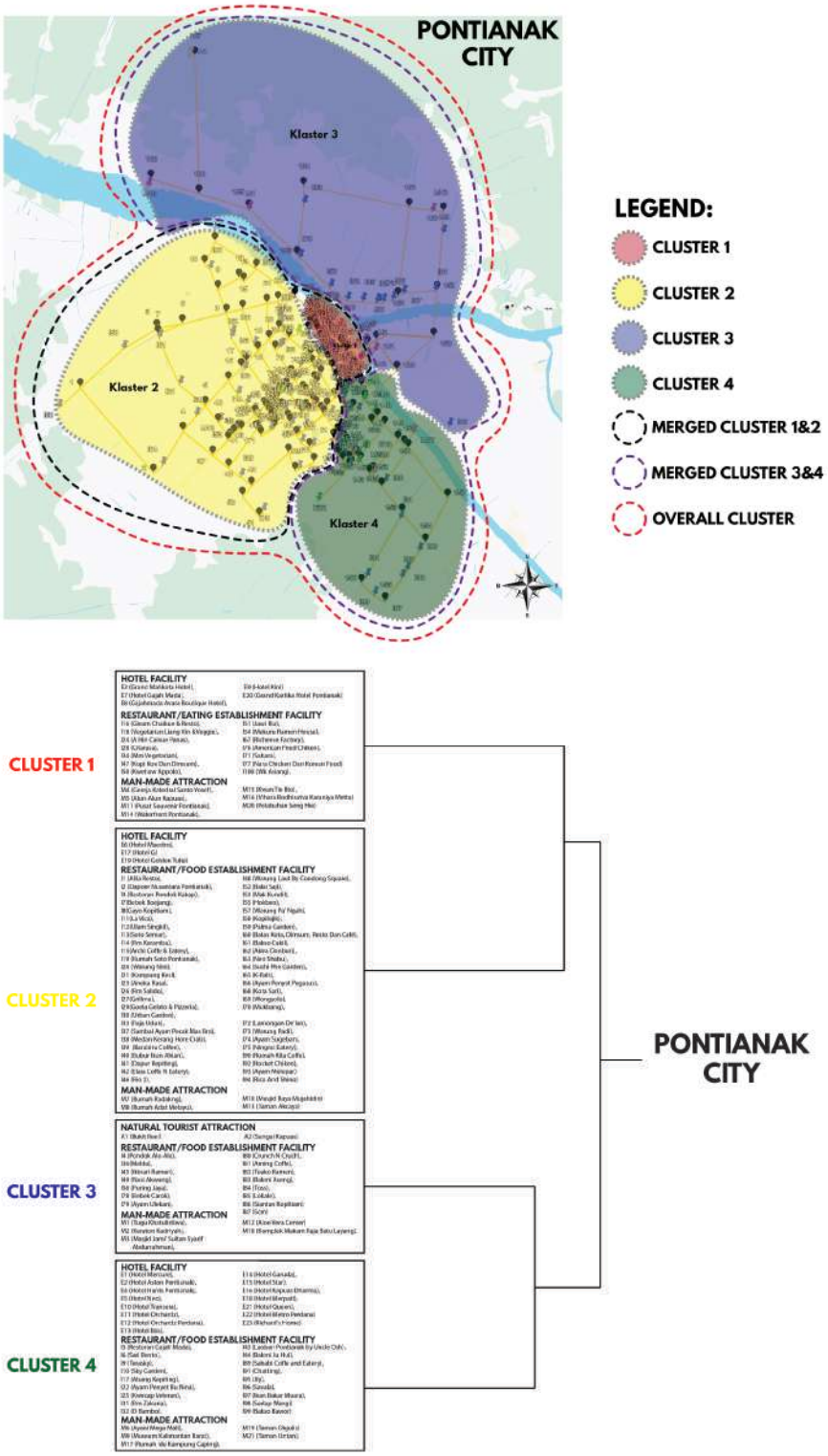


Figure 5. Visualization of the Results of the Hierarchical Clustering of Pontianak City (Source: Author, 2025)

From figure 5, clusters 1 and 2 share a dining-and-heritage profile, whereas Clusters 3 and 4 differ thematically, so the second pairing may reflect similar connectivity patterns rather than thematic similarity. Cluster 2 is a culinary cluster: it holds 51 of the 98 restaurants/food establishment but only four attractions (Rumah Radakng (M7), Rumah Adat Melayu (M8), Masjid Raya Mujahidin (M10), and Taman

Akcaya (M13)), roughly 13 restaurants per attraction. Cluster 4 is the accommodation and commerce cluster, with 15 of the 23 hotels, a shopping mall, the West Kalimantan Museum, and urban parks. Pan et al. (2025) note that tourists tend to conduct excursions near the hotels where they stay, so this cluster is a plausible base for visits to the heritage clusters.

Cluster 1 combines riverside and religious sites (Alun-Alun Kapuas (M5), Waterfront Pontianak (M14), Gereja Katedral Santo Yosef (M4), Kwan Tie Bio (M15), dan Vihara Bodhisatva Karaniya Metta (M16)) with five hotels. Cluster 3 contains both natural attractions (Bukit Reel (A1) and Sungai Kapuas (A2)) and royal heritage such as Keraton Kadriyah (M2) and Masjid Jami Sultan Syarif Abdurrahman (M3), but no hotel, and the cluster linked to Mempawah through the national road. Visitors to it therefore depend on lodging in other clusters, which makes it an outward-oriented link rather than a self-contained destination.

Analysis of Road-Network Connectivity and Hierarchical Clustering of Mempawah Regency



Figure 6. Distribution of Nodes, Natural Tourist Attractions, Hotel Facilities, Restaurant/Food Establishment Facilities, and Man-Made Tourist Attractions in Mempawah Regency (Source: Author, 2025)

Figure 6 illustrates the spatial distribution of tourism-related elements in Mempawah Regency, comprising 6 natural tourist attractions (Code 'B'), 6 hotel facilities (Code F'), 18 restaurant/ eating-place facilities (Code 'J'), 9 man-made tourist attractions (Code 'N'), and 45 road-network nodes (Code with number). These code color categories facilitate the identification of the spatial distribution and connectivity patterns among tourism attractions and supporting facilities within the road network.

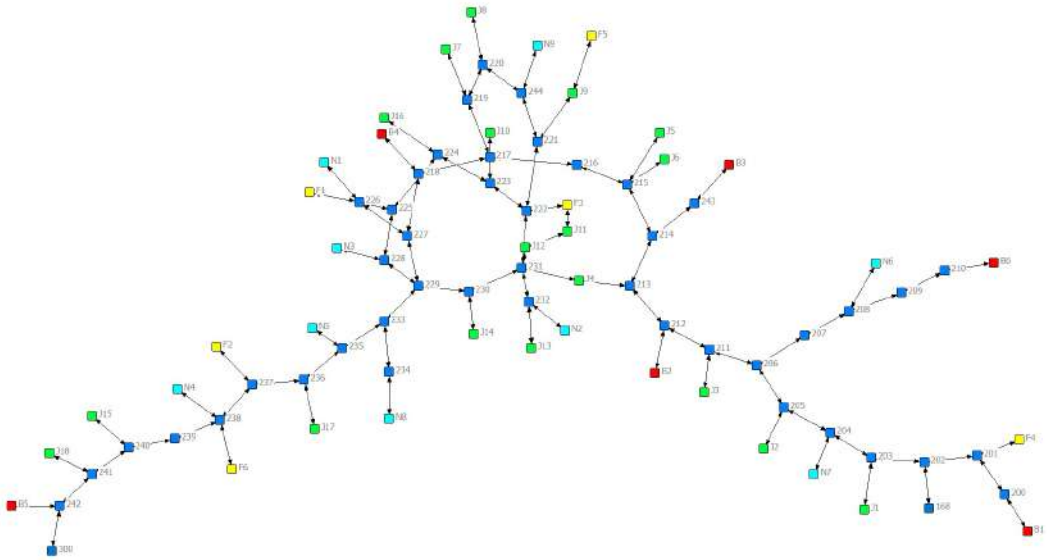


Figure 7. Nodes between the Road Network, Natural Tourist Attractions, Hotel Facilities, Restaurant/Food Establishment Facilities, and Man-Made Tourist Attractions in Mempawah Regency (Source: Author, 2025)

Based on Figure 7 shows the network generated in UCINET. Natural attractions are coded in red with the prefix 'B', hotels in yellow (F), restaurants/food establishments in green (J), and man-made attractions in light blue (N). Road network nodes are shown in blue and numbered 200-244.

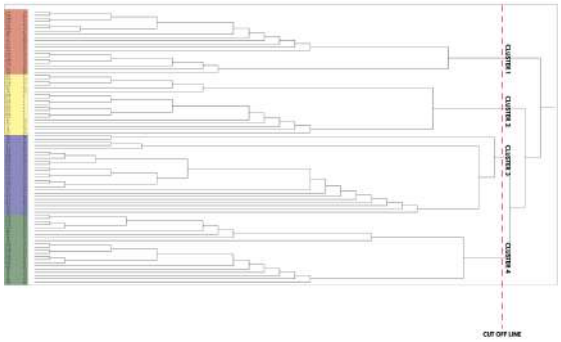


Figure 8. Hierarchical Cluster Dendrogram of Mempawah Regency (Source: Author, 2025)

Based on hierarchical clustering results in UCINET, a dendrogram was generated for Mempawah Regency, consisting of 33 levels and total number of nodes 84 formed from a combination of the road network and various tourism elements. Each hierarchical level reflects the progressive integration of interconnected elements within the spatial network.

An appropriate cut-off point was established at a hierarchical level where substantial variations in inter-cluster distances were observed. Following this segmentation, Mempawah Regency was classified into four major clusters, each representing distinct patterns of spatial distribution and thematic relationships among tourism elements across the regency. The four clusters formed report the connectivity between road nodes (number coding 200-244) and natural tourist attractions (B), Hotel Facilities (F), Restaurant/Food establishment Facilities (J), and man-made attractions (N).

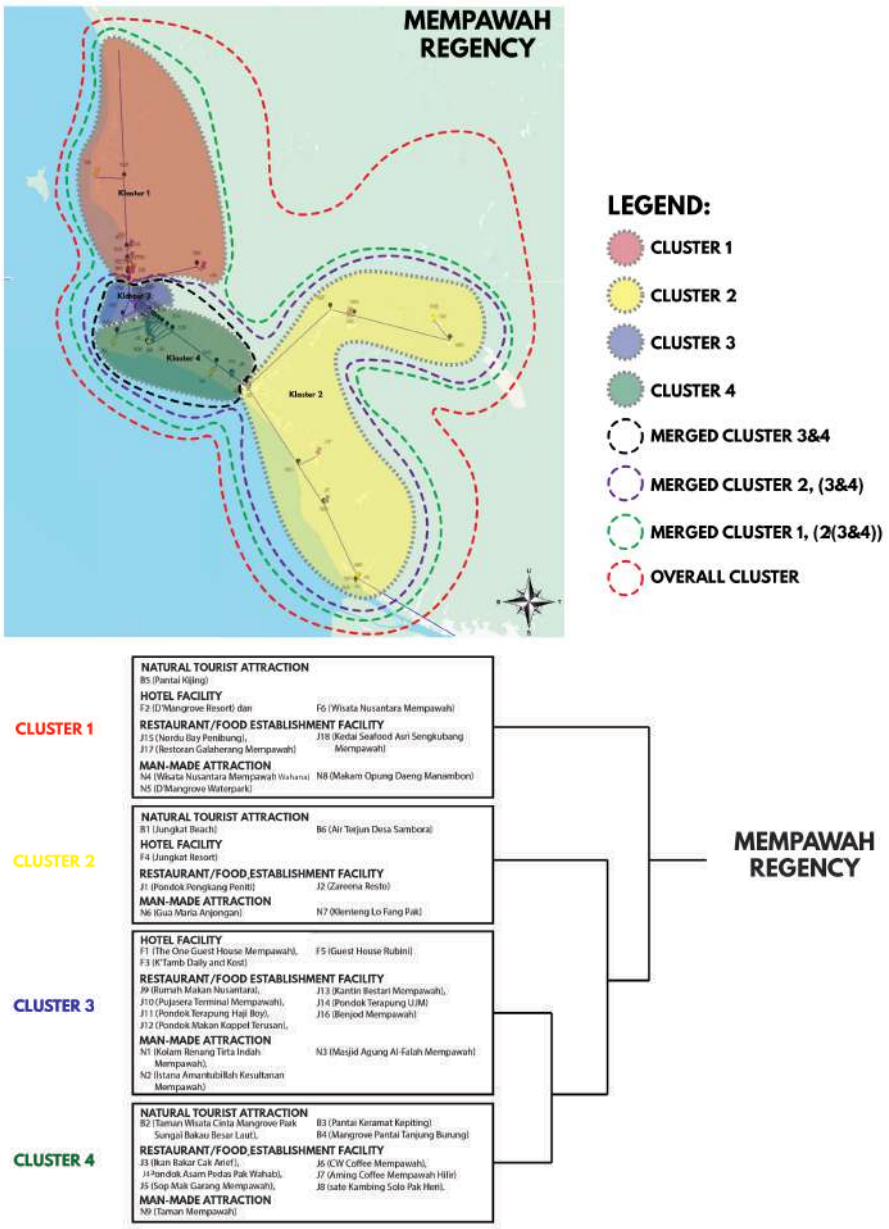


Figure 9. Visualization of Hierarchical Clustering Results for Mempawah Regency (Source: Author, 2025)

Figure 9 translates the dendrogram into four clusters and lists the tourism nodes grouped in each. Clusters 3 and 4 merge first, Cluster 2 joins next, and Cluster 1 joins last, making it the most distinct group. Cluster 1 combines coastal and mangrove-themed leisure (Pantai Kijing (B5), D'Mangrove Resort (F2) and D'Mangrove Waterpark (N5)) with a heritage tomb (Makam Opung Daeng Manambon (N8)). Cluster 3 is service-oriented, with three hotels, seven restaurants, and the palace (Istana Amantubillah Kesultanan Mempawah (N2) and great mosque (Masjid Agung Al-Falah Mempawah (N3)) but no natural attraction, whereas Cluster 4 holds three coastal and mangrove attractions and six restaurants but no hotel.

Analysis of Road-Network Connectivity and Hierarchical Clustering of Singkawang City



Figure 10. Distribution of Nodes, Natural Tourist Attractions, Hotel Facilities, Restaurant/Food Establishment Facilities, and Man-Made Tourist Attractions in Singkawang City (Source: Author, 2025)

Figure 10 illustrates the spatial distribution of tourism-related elements in Singkawang City, comprising 20 natural tourist attractions (Code 'C'), 14 hotel facilities (Code G'), 17 restaurant/ eating-place facilities (Code 'K'), 14 man-made tourist attractions (Code 'O'), and 116 road-network nodes (Code with number). These code color categories facilitate the identification of the spatial distribution and connectivity patterns among tourism attractions and supporting facilities within the road network.

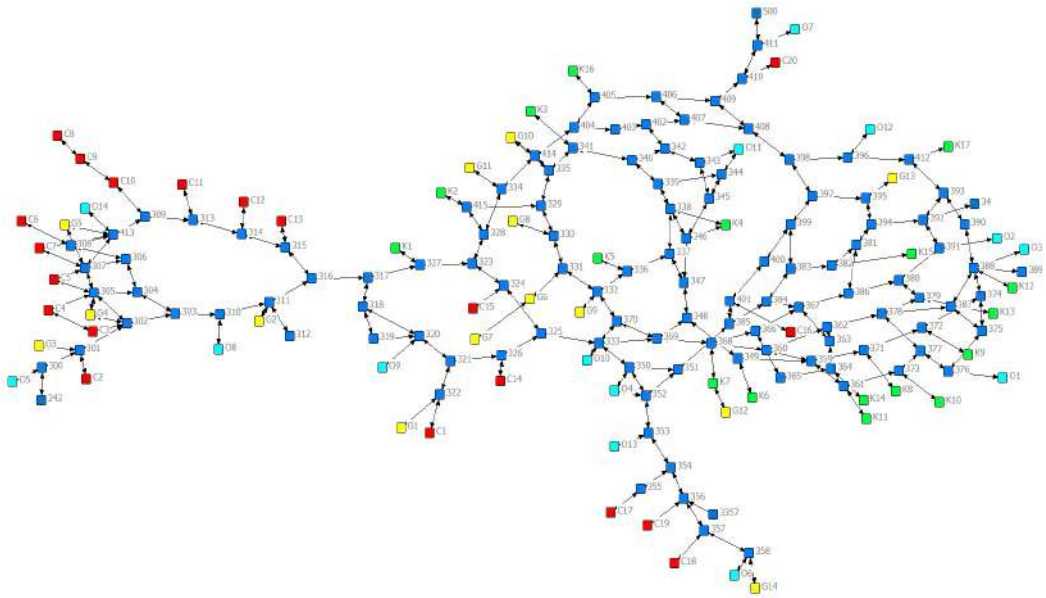


Figure 11. Nodes between the Road Network, Natural Tourist Attractions, Hotel Facilities, Restaurant/Food Establishment Facilities, and Man-Made Tourist Attractions in Singkawang City (Source: Author, 2025)

Based on Figure 11 shows the network generated in UCINET. Natural attractions are coded in red with the prefix 'C', hotels in yellow (G), restaurants/food establishments in green (K), and man-made attractions in light blue (O). Road network nodes are shown in blue and numbered 300-415.

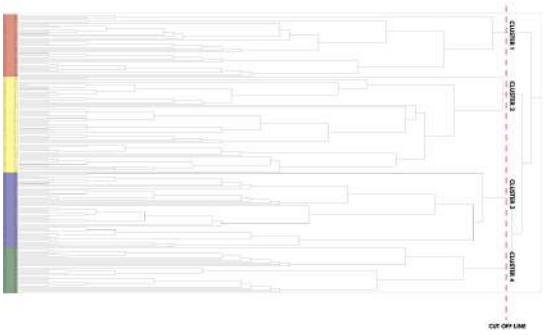


Figure 12. Hierarchical Cluster Dendrogram of Singkawang City (Source: Author, 2025)

Based on hierarchical clustering results in UCINET, a dendrogram was obtained with 53 levels and total number of nodes 181, formed from a combination of road networks and various tourism elements in Singkawang City. Shorter and longer joining lines in the dendrogram indicate stronger and weaker interconnectedness between objects, respectively.

The cut-off points were determined at specific hierarchical levels where substantial variations in inter-cluster distances were identified. Based on this segmentation, Singkawang City was classified into four major clusters, each representing distinct spatial configurations and thematic relationships among tourism elements within the city's spatial structure. The four clusters formed report the interconnectedness among road nodes (number coding 300-415), natural tourist attractions (C), hotel facilities (G), restaurant facilities (K), and man-made tourist attractions (O).

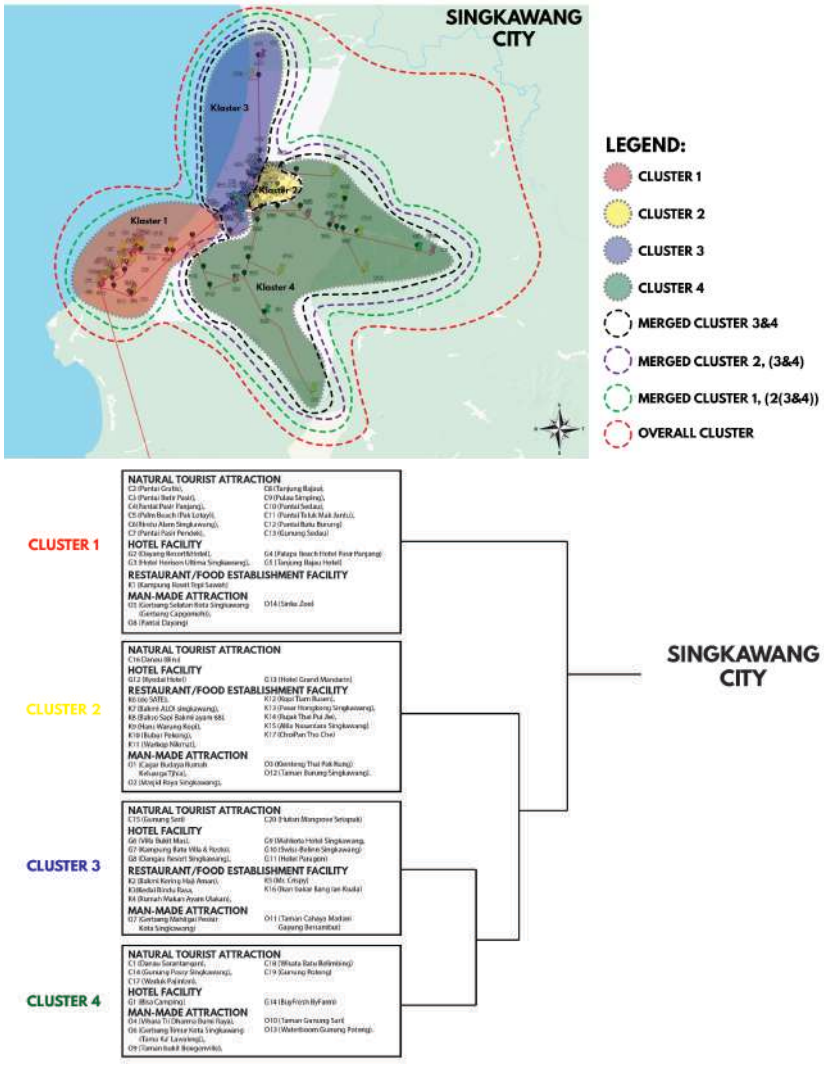


Figure 13. Visualization of Singkawang City Hierarchical Clustering Results (Source: Author, 2025)

Figure 13 translates the dendrogram into four clusters and lists the tourism nodes grouped in each. The same merge order occurs, with Cluster 1 joining last. Cluster 1 is the beach cluster, with 12 of the city's 20 natural attractions, four hotels, and a single restaurant. Cluster 2 is the dining and cultural cluster, with 11 restaurants and four heritage and park attractions, while Cluster 3 is accommodation-oriented, with six hotels. Cluster 4 holds upland and reservoir attractions and five man-made attractions but no restaurant/food establishment.

Analysis of Road-Network Connectivity and Hierarchical Clustering of Sambas Regency

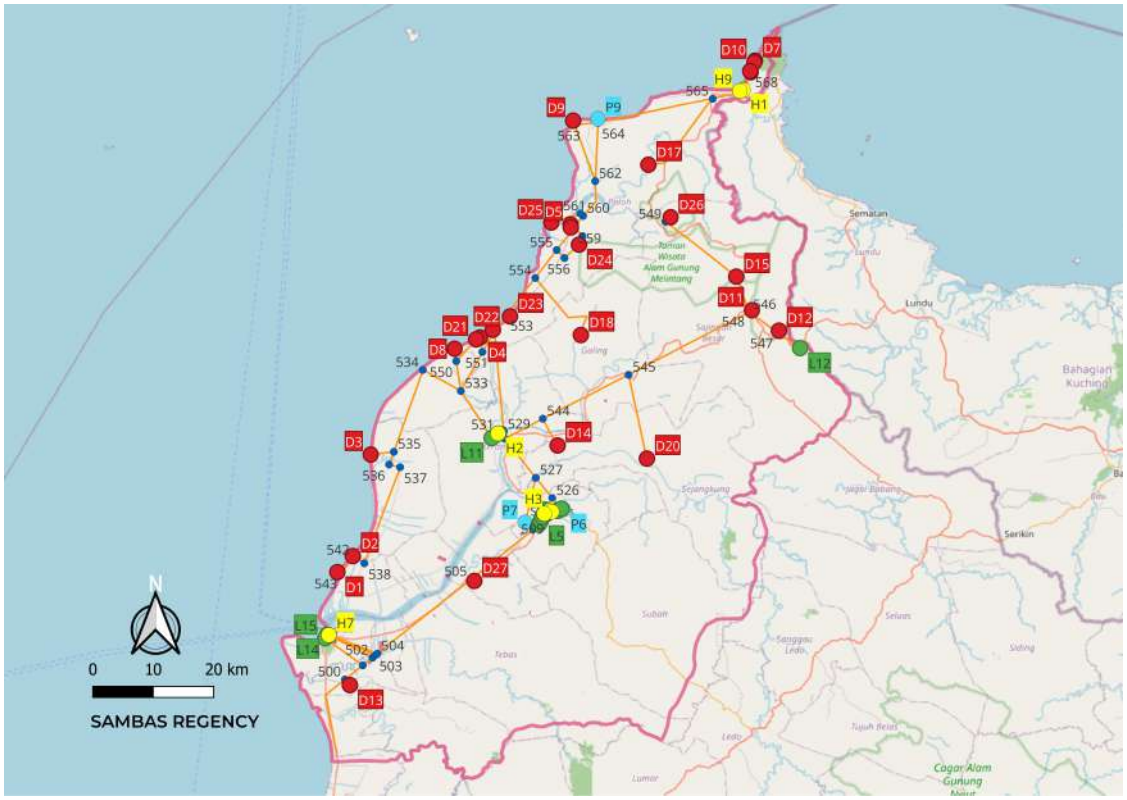


Figure 14. Distribution of Nodes, Natural Natural Tourist Attractions, Hotel Facilities, Restaurant/Food Establishment Facilities, and Man-Made Tourist Attractions in Sambas Regency (Source: Author, 2025)

Figure 14 illustrates the spatial distribution of tourism-related elements in Sambas Regency comprising 27 natural tourist attractions (Code 'D'), 9 hotel facilities (Code H'), 16 restaurant/food establishment facilities (Code 'L'), 9 man-made tourist attractions (Code 'P'), and 73 road-network nodes (Code with number). Total number of nodes 134. These code color categories facilitate the identification of the spatial distribution and connectivity patterns among tourism attractions and supporting facilities within the road network.

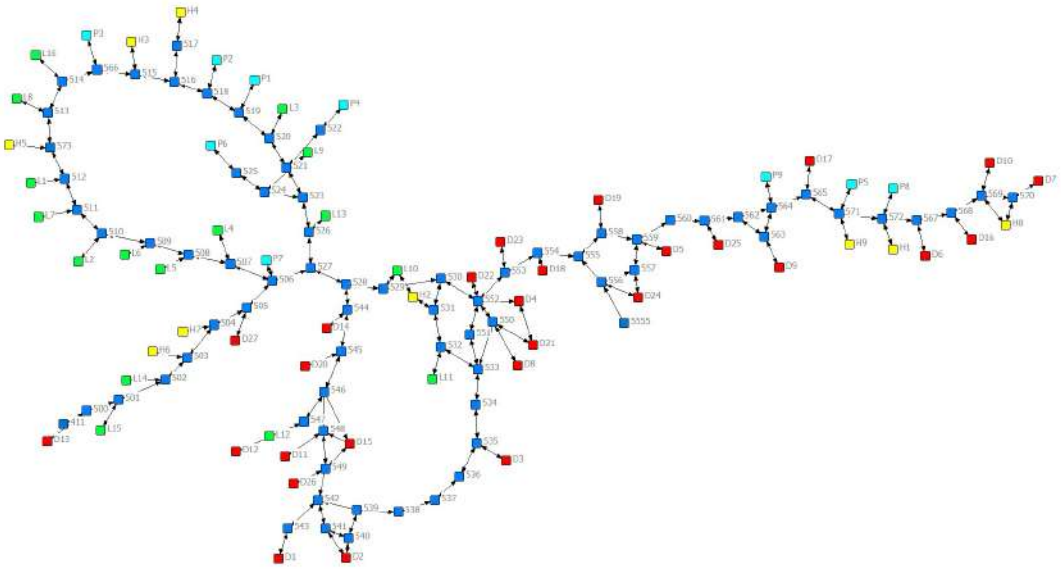


Figure 15. Nodes between the Road Network, Natural Tourist Attractions, Hotel Facilities, Restaurant/Food Establishment Facilities, and Man-Made Tourist Attractions in Sambas Regency (Source: Author, 2025)

Based on Figure 15 shows the network generated in UCINET. Natural attractions are coded in red with the prefix 'D', hotels in yellow (H), restaurants/food establishments in green (L), and man-made attractions in light blue (P). Road network nodes are shown in blue and numbered 500-572.

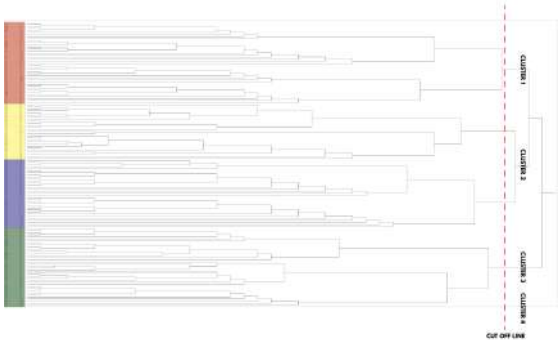


Figure 16. Hierarchical Cluster Dendrogram of Sambas Regency (Source: Author, 2025)

Based on hierarchical clustering results in UCINET, a dendrogram was obtained with 53 levels and total number of nodes 134, formed from a combination of road networks and various tourism elements in Sambas Regency. Shorter and longer joining lines in the dendrogram indicate stronger and weaker interconnectedness between objects, respectively.

After the cut-off, Sambas Regency was grouped into four main cluster structures to show the spatial and thematic linkage patterns of tourism. The four clusters reported the connections among road nodes (number coding 500-572), natural tourist attractions (D), Hotel Facilities (H), Restaurant Facilities/Food establishments (L), and man-made attractions (P).

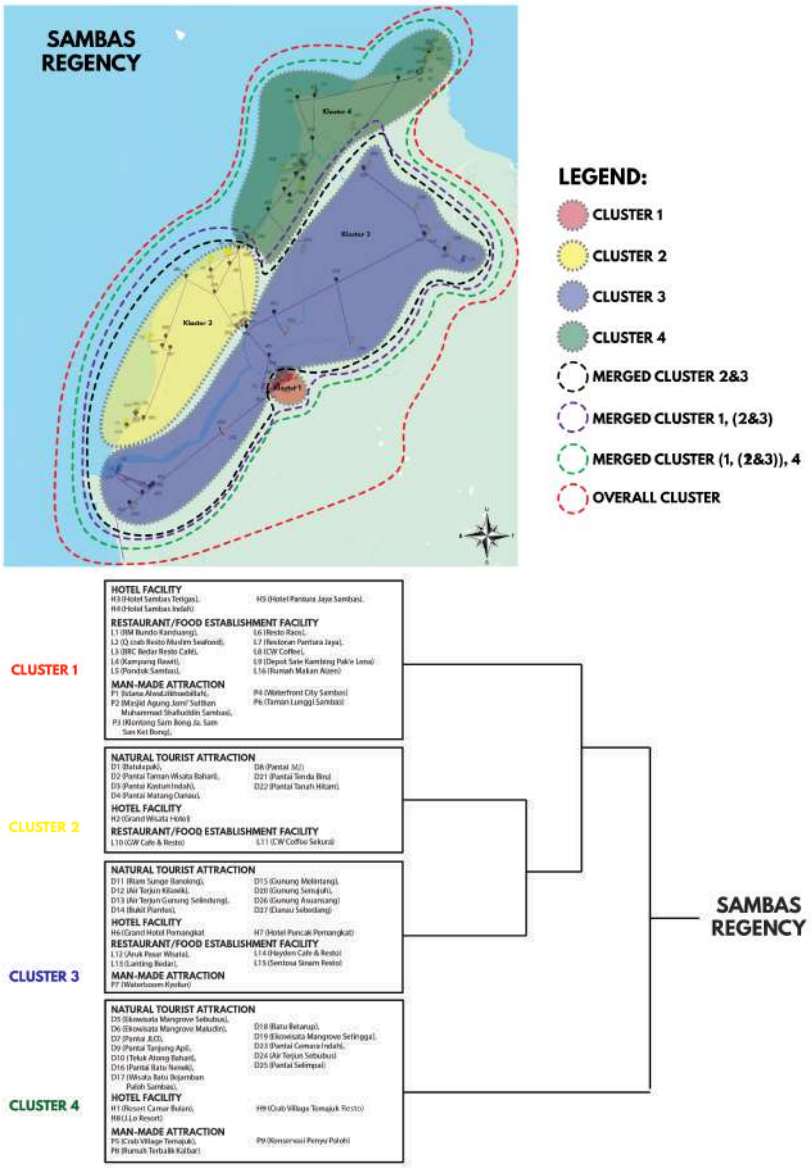


Figure 17. Visualization of Hierarchical Clustering Results for Sambas Regency (Source: Author, 2025)

Figure 17 translates the dendrogram into four clusters and lists the tourism nodes grouped in each. Clusters 2 and 3 merge first, followed by Cluster 1, and Cluster 4 joins last. Cluster 1 is the urban-historical cluster, with the palace, the grand mosque, three hotels, and 10 restaurants but no natural attraction. Natural attractions split by landscape: beaches in Cluster 2, mountains, waterfalls, and a lake in Cluster 3, and mangrove ecotourism and remote beaches in Cluster 4, which has 12 natural attractions, three hotels, and no restaurant.

Discussion

In all four study areas, nodes were not grouped by attraction type alone. They were grouped by the combination of attractions and supporting facilities reachable through similar road-network connections. Each cluster therefore carries a distinct functional profile, such as culinary, accommodation-oriented, heritage, beach, or mangrove. Hierarchy here can be read in both senses introduced in the literature review. Structurally, it is the nested grouping shown by the dendrogram. Functionally, it is the role each group plays in the wider

tourism system. Linkage distance represents dissimilarity in connectivity patterns, not physical distance. A cluster that joins late is one whose pattern of connections differs most from the rest of the network, not simply one that lies far away. The Pontianak case supports this reading. Clusters 3 and 4 differ thematically, yet they merge, which suggests that connectivity patterns, rather than thematic similarity, shaped their grouping.

A consistent pattern emerges across the areas. Clusters rich in services are located in urban or historic cores and act as bases. Clusters dominated by natural attractions depend on them. In Pontianak, Cluster 2 holds 51 of the 98 restaurants but only four attractions, while Cluster 4 holds 15 of the 23 hotels together with the museum, a shopping mall, and urban parks. Cluster 3 has no hotel, so visitors may need lodging elsewhere. This agrees with Pan et al. (2025) , who note that tourists tend to make excursions near the hotels where they stay. The same structure appears elsewhere:

a. In Mempawah, Cluster 3 is service-oriented, while Cluster 4 holds coastal and mangrove attractions without a hotel.
b. In Singkawang, Cluster 3 is accommodation-oriented and Cluster 2 is dining-oriented, while Cluster 4 has no restaurant.
c. In Sambas, Cluster 1 is urban-historical with three hotels and ten restaurants, while Cluster 4 has 12 natural attractions and no restaurant.

These findings are consistent with the view of tourist regions as attractions linked to services and transportation (Gunn, 1972). They also resemble the finding that nature-dominated clusters tend to have poorer facilities (Pan et al., 2025). The most distinct clusters are those where coastal or remote natural attractions dominate: Cluster 1 in Mempawah and Singkawang, and Cluster 4 in Sambas.

Regional hierarchy across the four areas. The four separate analyses suggest a provisional regional hierarchy consistent with the core–periphery logic of Friedmann (1966) and the service-level differentiation of Christaller (1966)

a. Pontianak may be the core node. It has the largest concentration of facilities (23 hotels, 98 restaurants, and 21 man-made attractions), and its dendrogram is the most open. One of its clusters is linked to Mempawah through the national road.
b. Mempawah is a transition zone. It combines heritage, service, and coastal-mangrove clusters at a smaller scale.
c. Singkawang is a coastal tourism sub-center. It holds 20 natural attractions, 12 of them in a single beach cluster, and it has separate accommodation and dining clusters.
d. Sambas is a peripheral zone. It has the largest number of natural attractions (27) but comparatively few supporting facilities, and its mangrove and remote-beach cluster has no restaurant.

The two studies above differ from this one in setting and scale, so the comparison is conceptual, not a test of equivalence. Sugiarti et al. (2020) examined one fortress in an urban setting. Rahmatin & Nawangsari (2025) examined a protected geopark using qualitative governance evidence. This study analyzed four coastal areas using binary road-network connectivity, and it contains no stakeholder or policy data.

Within those limits, the comparison sharpens three points. First, the clusters give a corridor-scale, comparative form to the external-management argument of Sugiarti et al. (2020). Their observation that an attraction depends on synergy with surrounding facilities appears here as recurring cluster structures. Pontianak's Cluster 3 has natural and royal-heritage attractions but no hotel, so visitors may use

facilities in other clusters, and the nature-dominated clusters in Mempawah, Singkawang, and Sambas show the same dependence. The difference is that Sugiarti et al. take the fortress as the center of the tourism package, whereas hierarchical clustering lets the roles emerge from the connectivity data. The fortress study also treats internal management, such as interpretation and site facilities, as a separate task. The clustering cannot see this level, so it should not be read as a measure of attraction quality or visitor experience.

Second, the Ijen evidence suggests that spatial hierarchy alone does not ensure that local community's benefit. The clusters show where facilities are missing, such as restaurants in Singkawang's Cluster 4 and Sambas' Cluster 4, and hotels in Mempawah's Cluster 4. Filling such gaps could follow a top-down pattern or a participatory one, and the Ijen findings on limited local empowerment and entrepreneurship development suggest this choice matters. The Ijen findings also caution that a hierarchy used to channel visitors toward the core node and the sub-center could intensify mass-tourism pressure on the most connected nodes. The clustering does not test either outcome. The recommendation that gaps be filled with small-scale, locally managed services is therefore a planning hypothesis informed by the Ijen evidence, not a result of this study.

Third, the Ijen study concerns an area spanning two regencies, which bears on a corridor that crosses two cities and two regencies with separate administrations. The road link between Pontianak and Mempawah, and the peripheral position of Sambas, imply that hierarchy-based guidelines would require coordination across administrative boundaries. How that coordination should work is beyond the data collected here.

Hierarchy in this study therefore reflects connectivity and facility readiness, not the intrinsic appeal of attractions. This is consistent with the Introduction, which treats infrastructure as a supporting factor rather than the main determinant of hierarchy. The approach also adds to earlier work that builds links from tourist movement data (Ding et al., 2024; Ma et al., 2024). It shows that road-network connectivity among attractions, hotels, and restaurants can structure a coastal corridor.

Implications for the blue and green economy. The hierarchy offers a basis for differentiated development. In Pontianak, riverside and green open-space attractions such as Sungai Kapuas, the waterfront, and urban parks can be maintained as high-quality urban nodes. In Mempawah, Singkawang, and Sambas, beaches and mangroves are the main blue-economy assets. Their long-term attractiveness depends on managing marine resources and green spaces within carrying capacity, in line with sustainable tourism principles (Gajdošík et al., 2018; Gupta et al., 2024). Clusters without hotels or restaurants point to where small-scale, locally managed services could be added, rather than large facilities that exceed the capacity of fragile coastal areas. Strengthening connections between peripheral clusters and service bases would also improve inter-regional connectivity. In Sambas it could support border ecotourism and cross-border integration with Malaysia, consistent with the provincial tourism master plan (Pemerintah Provinsi Kalimantan Barat, 2018).

Links were defined as binary road connectivity, so tourist flows, travel time, and attraction quality were not weighted. Each area was clustered separately with its own cut-off, so cluster numbers are not directly comparable across areas. Governance, community participation, and site-level management were not measured, and these were the dimensions emphasized in the comparison studies. Future research could combine road connectivity with visitor-flow data and centrality measures (Muazir et al., 2024), and pair the resulting hierarchy with stakeholder interviews and policy analysis, as in Rahmatin & Nawangsari (2025).

CONCLUSION

This study aimed to identify the distribution of coastal tourist attractions in West Kalimantan, map their connectivity, and derive a hierarchy of attractions using hierarchical clustering of road-network connectivity in UCINET. Each of the four areas, Pontianak City, Mempawah Regency, Singkawang City, and Sambas Regency, formed four clusters with distinct functional profiles. Service-rich clusters in urban and historic cores may serve as bases, while natural coastal clusters are more distinct and may rely on those bases for accommodation and dining. Provisionally, Pontianak is the core node, Mempawah a transition zone, Singkawang a coastal tourism sub-center, and Sambas a peripheral zone with potential for border ecotourism.

These findings address the gap in studies that use road-network connectivity among attractions, hotels, and restaurants to structure a coastal corridor. In practice, they support sustainability-oriented guidelines grounded in the blue and green economy. These include strengthening coastal corridors, adding small-scale facilities in clusters that lack them, conserving mangroves, rebeaches, and green open spaces, and improving connectivity to peripheral and cross-border destinations. The comparison with spatial-management and governance studies indicates that the hierarchy is best treated as a spatial basis for planning, to be paired with participatory governance and with site-level management of individual attractions. Future research should include tourist flows, travel time, and attractiveness weights to refine the hierarchy.

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AI USE STATEMENT

The authors acknowledge the use of artificial intelligence (AI) tools as supplementary assistance in the preparation of this manuscript. In particular, ChatGPT (OpenAI) was employed to support English language refinement, including grammatical corrections, enhancement of clarity, and improvement of academic writing style. However, AI tools were not utilized for data processing, statistical analysis, hypothesis testing, interpretation of research findings, or figure preparation. All aspects of the research, including conceptual development, research design, methodological decisions, data analysis, interpretation of results, and formulation of conclusions, were independently undertaken by the authors. The authors retain full responsibility for the accuracy, academic integrity, and originality of the manuscript.

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