

## Identification of centrality of West Kalimantan tourist attractions based on network analysis

### Identifikasi sentralitas daya tarik wisata Kalimantan Barat berdasarkan analisis jaringan

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#### ABSTRACT

Tourism destinations represent a vital element and the primary motivator for tourists in determining their travel and visitation patterns. Consequently, it is essential to implement effective planning strategies that align with the diverse motivations of tourists. One of the scientific discussions in tourism planning or development is through network analysis. With network analysis, it can explain the relationship or relationship between tourist attractions so that in the future it can be further developed how the attraction cluster in a tourist destination can be developed and directed. This research sees that the priority in terms of centrality should be given to the many attractions in West Kalimantan. This study aims to identify relationships or relationships between tourist attractions in West Kalimantan to be able to see the trend of networking (centrality), can be in the form of centralization, connectedness, clusters, and others. This research uses a network analysis approach which in principle is divided into several methods such as centrality calculations carried out with analytical techniques/tools such as degree, closeness, betweenness, and eigenvector. From the results obtained, the cluster of tourist attractions spread evenly in each region. The tourist attraction cluster with the most interaction is located in Bengkayang Regency, Pontianak City, North Kayong Regency, Ketapang Regency, and Kapuas Hulu Regency. For tourist attraction clusters with easy access, they are in the Sambas Regency and Singkawang City areas. Clusters of tourist attractions that become hubs are located in Sanggau Regency and Ketapang Regency. Then the cluster of tourist attractions with the most central point is located in Singkawang City. The road network (access) in the configuration is very influential in the connectivity between regions in reaching tourist attractions.

#### HOW TO CITE ITEM

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#### ABSTRAK

*Destinasi pariwisata merupakan unsur vital sekaligus penggerak utama bagi wisatawan dalam memutuskan perjalanan dan kunjungan ke suatu daerah, untuk itu perencanaan yang baik perlu dilakukan untuk memberikan pelayanan yang sesuai dengan motivasi wisatawan. Salah satu diskusi keilmuan dalam perencanaan atau pengembangan pariwisata adalah melalui analisis jaringan. Dengan analisis jaringan, dapat menjelaskan hubungan atau relasi antara atraksi-atraksi wisata sehingga kedepannya dapat dikembangkan lebih lanjut bagaimana "klaster" atraksi dalam sebuah destinasi wisata dapat dikembangkan dan diarahkan. Penelitian ini bertujuan mengidentifikasi relasi atau hubungan antara atraksi wisata yang ada di Kalimantan Barat untuk dapat dilihat kecenderungan jejaringnya (sentralitas/keterpusatan), dapat berupa keterpusatan, keterhubungan, klaster, dan lain-lain. Penelitian ini melihat*

*bahwa dengan banyaknya atraksi yang ada di Kalimantan Barat perlu pertimbangan prioritas dalam hal sentralitas. Penelitian ini menggunakan pendekatan analisis jaringan (sentralitas) yang secara prinsip terbagi atas beberapa metode seperti Perhitungan keterputusan dilakukan dengan teknik/alat analisa seperti degree, closeness, betweenness, dan eigenvector. Dari hasil yang didapat, sentralitas atraksi wisata menyebar secara merata di setiap daerah. Wilayah atraksi wisata dengan interaksi terbanyak (degree) terletak pada daerah Kabupaten Bengkayang, Kota Pontianak, Kabupaten Kayong Utara, Kabupaten Ketapang, dan Kabupaten Kapuas Hulu. Untuk atraksi wisata dengan akses yang mudah (closeness) berada di daerah Kabupaten Sambas dan Kota Singkawang. Sedangkan atraksi wisata yang menjadi penghubung atau "hub" (betweenness) terletak di daerah Kabupaten Sanggau dan Kabupaten Ketapang. Kemudian atraksi wisata (eigenvector) dengan titik paling sentral terletak di Kota Singkawang. Jaringan jalan (access) pada konfigurasi sangat berpengaruh dalam keterhubungan antar wilayah dalam menjangkau atraksi wisata, sehingga perlu disesuaikan lebih lanjut mengenai wilayah prioritas terkait dengan sentralitas*

## INTRODUCTION

Tourism is an incredibly important industry worldwide, with a significant economic impact. In Indonesia, it is one of the biggest contributors to foreign exchange earnings, accounting for 10-12 million USD in 2013-2015 (Kemenparekraf/ Baparekraf RI, 2020), ranking 4th after palm oil, new coals, and oil & gas. This result makes it a more reliable sector than oil and gas exports, which have a limited lifespan. However, the number of foreign tourists visiting Indonesia fluctuates. In the 2019 Travel & Tourism Competitiveness Index report (World Economic Forum, 2019), Indonesia ranked 40th out of 140 countries, and 12th out of 22 countries in the Asia Pacific region. This is still behind Thailand, Malaysia, and Singapore. Despite this, Indonesia has made good progress in recent years, improving its ranking in the index. This suggests that the tourism sector has the potential to grow further and become even more important to the Indonesian economy.

Tourism destinations are a vital element and the main driving force for tourists in deciding where to travel and visit. For this reason, good planning is essential to provide services that meet the motivations of tourists and are aligned with the country's strategic tourism plan. The national tourism development plan considers several factors when developing tourism destinations, including: the relationship between tourist destinations and regional and/or national tourism gateways, the relationship between components of attractiveness and movements in the tourist destination, the development of transportation networks and the integration of infrastructure networks between gateways and existing destinations (National Tourism Development Master Plan, 2011)

In the dynamic landscape of the tourism industry, the interplay between tourism attraction connectedness and transportation networks has emerged as a critical area of study (Canson & Caelian, 2022) Tourism is a multifaceted phenomenon that involves the movement of people from their origin to various destinations, where they engage in activities and consume services.(Hernández & González-Martel, 2017) This complex web of interactions between tourism stakeholders, including tourists, destination hosts, and transportation providers, highlights the need for a comprehensive understanding of the underlying dynamics.(Hartman & Heslinga, 2022)

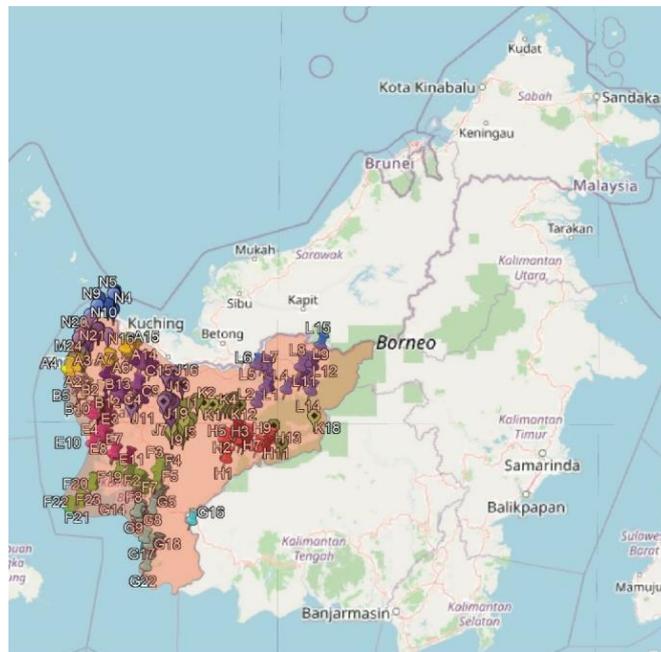
Tourism scientists are increasingly discussing the concept of "network systems" in tourism. Tourism can be broadly defined as a complex network of activities, including tourist movements, travel between tourist attractions and routes, relationships between tourism and management businesses, and more (Gajdošík, 2015). The movement of tourists forms a network that connects their origin to their destination, also known as tourism flow (Chung et al., 2020). Tourism flow is the central focus of tourism geography, and it consists of at least three components: direction, level of visit, and the relationship between locations (Peng et al., 2016).

In a tourist destination, the destination itself can be seen as a "node" and the route between attractions as a "link". Network analysis can be used to classify the relationships between attractions and other stakeholders, and to explain the characteristics of these connections. Network analysis is a useful tool for tourism research because it can visualize the movement of tourists, calculate the relationships between nodes, and explain the structural patterns that connect them (Zeng, 2018)

A tourism destination network is a geographic system that connects destinations and the routes between them. It consists of three main components: destinations (as nodes), routes (as links), and the relationships between nodes. Destinations can be connected directly or indirectly, and the weight or form of these relationships creates a structure of further linkages (Hua & Wondirad, 2021). In a tourist destination, the tourism industry, including hotels and tourist attractions, tends to cluster together. This suggests that the tourism industry in a destination is geared towards serving tourists who want to visit multiple attractions (Chhetri et al., 2013). Tourism development

is a complex process that involves many interrelated resources. For this reason, it is possible to use dynamic processes to form clusters and networks between different elements in tourism studies (Brás *et al.*, 2010).

In an urban spatial configuration, the road network is a key element that can shape access, distance, distribution, placement, "closeness", and "degrees". As Ni *et al.* (2016) noted, the urban road network plays a very important role in shaping urban activities and the spatial distribution of urban service facilities. Centrality/centralization is one of the measuring instruments used to evaluate urban road networks. The field of urban study has long been a subject of fascination for researchers, urban planners, and policymakers alike, as they seek to understand the complex dynamics that shape the growth and development of cities (Haghani *et al.*, 2023). One particularly insightful approach to this field is the application of network analysis, which provides a framework for examining the intricate relationships and interconnections that underlie urban systems (Yap *et al.*, 2023). From this perspective, the urban landscape can be conceptualized as a complex network, where various elements such as roads, transportation systems, and social interactions serve as the nodes and links that define the overall structure (Ward *et al.*, 2011), and it can be divided into several substances, such as transactions, direction/destination, structural, density, connection, and optimization. One of these substances is the measurement of centrality/centrality (Pavlovich, 2003; Scott *et al.*, 2008).



**Figure 1.** Distribution of Tourist Attractions in West Kalimantan  
 Source: Google Earth, accessed in July, 2023

Network analysis can be used to study tourist destinations. A tourist destination can be considered a location that interacts and collaborates with other parties to support a tourism product. In general, network analysis in tourism can explain the relationship between the parties or resources (actors) that are quantitatively related in terms of relationships. Each actor can access the network as a whole or as a specific actor (Gajdošik, 2015).

West Kalimantan province is comprised of 14 cities and regencies, encompassing a total area of 146,807 square kilometers (Kalbarprov.go.id). As indicated in the news publication delivered by RRI (Harmanta, 2023) West Kalimantan Province has considerable tourism potential, comprising 744 objects of tourist attraction. The aforementioned tourism potential is divided into several categories. A total of 499 tourist attractions are classified as "nature," comprising the largest portion of the province's tourism industry. Another 92 attractions are designated as "cultural," while 53 are categorized as "artificial," 33 as "religious," and 28 as "marine." Additionally, there are 16 historical, 10 culinary, and 10 agricultural tourist attractions, as well as two shopping tours and one educational tour. It is evident that further planning is required in order to integrate these diverse tourist attractions, while simultaneously ensuring that each retains its unique identity and appeal, as well as aligning them effectively with target markets. As stated by Hua and Wondirad (2021), destinations can be connected or not connected. In addition, a tourist destination can be defined as a location that interacts and cooperates with other parties to support a tourism product, and thus it is also necessary to pay attention to each cluster in order to create equity in accordance with the potential and the market. As outlined by Purwanto *et al.* (2021), in order to support tourism in West Kalimantan, which boasts a considerable number of attractions, it is essential to map tourism development with the support of a diverse range of stakeholders, namely the provincial, regency/city, and village governments, in addition to the private sector and investors.

From several description above, the purpose of this study is to identify the relationships between tourist attractions in West Kalimantan to see how they are structured as a network, including in terms of centers, connections, and clusters (Figure 1). This information can then be used to optimize the network or clustering in accordance with the nature of the relationships between the different tourist attractions

**METHODS**

This 2023 research will take West Kalimantan Province as a case study to investigate the distribution of tourist attractions, destinations, and interconnectivity. It will use the network analysis approach to study the relationships between tourist attractions/destinations (nodes/vertices) and their interconnections (links/edges). According to Borgatti et al. (2013), there are at least three basic approaches in network analysis: (1) centrality, (2) subgraphs or groups, and (3) equivalence. Each approach has several calculation methods, such as in/out degree, closeness, betweenness, and eigenvectors. Once the network structure is obtained, the results will be discussed to identify the characteristics of the existing attractions/destinations and the potential/problems that exist. The research activity entailed the completion of several stages, including the following:

1. Collection of data in the form of road and transportation networks (national, provincial, city, district).
2. The collection of data in the form of the distribution of tourist attractions.
3. The data collection of the distribution of tourist destinations in West Kalimantan
4. A comprehensive listing of all relevant relationships between the road networks and other geographical areas in West Kalimantan Province is required. Each relationship must be entered in a systematic manner, with all relevant data input in a node-by-node format.
5. A list of relationships between attractions in relation to the road and regional network in West Kalimantan Province was compiled and entered into a database. This database contains node-by-node relationships
6. A summary of the interaction data (incoming/outgoing) of the road network/region and tourist attractions in West Kalimantan Province. This presented in the form of a network diagram, with each point (nodes/vertices) connected to its connectors (links/edges)
7. The network analysis will examine and elucidate the centrality of the road and region network in West Kalimantan Province, as well as the interconnected tourist attractions. The analysis will be conducted using the UCINET software program.

**Table 1.** Analysis Tools

No	Analysis Tools	Definition	Source	Algorithm
1	Degree	The number of lines (links) associated with a single point; the number of links (lines) belonging to a single point	(Borgatti et al., 2013; N Scott et al., 2008)	$k_i^{in} = \sum_j a_{ji}$ $k_i^{out} = \sum_j a_{ij}$
2	Closeness	Reflecting how close the actors/points are to reaching another, one point becomes central if it can interact quickly with another	(S. Wasserman & Faust, 1994)	$C_C(n_i) = \left[ \sum_{j=1}^g d(n_i, n_j) \right]^{-1}$
3	Betweenness	Actors/points located in the middle; point among others; bridging point; deep flow controller network	(Borgatti et al., 2013; Stanley Wasserman & Faust, 1994)	$C_B(n_i) = \sum_{j < k} g_{jk}(n_i) / g_{jk}$
4	Eigenvector	Attempts to find the most central actor/point in terms of overall network structure; A measure of the "popularity" of a point connected to another point, where another point is Connect with each other	(Borgatti, 1995; Borgatti et al., 2013; S. Wasserman & Faust, 1994)	$e_i = \lambda^{-1} \sum_j a_{ij} e_j$

Source: Summarized from several sources

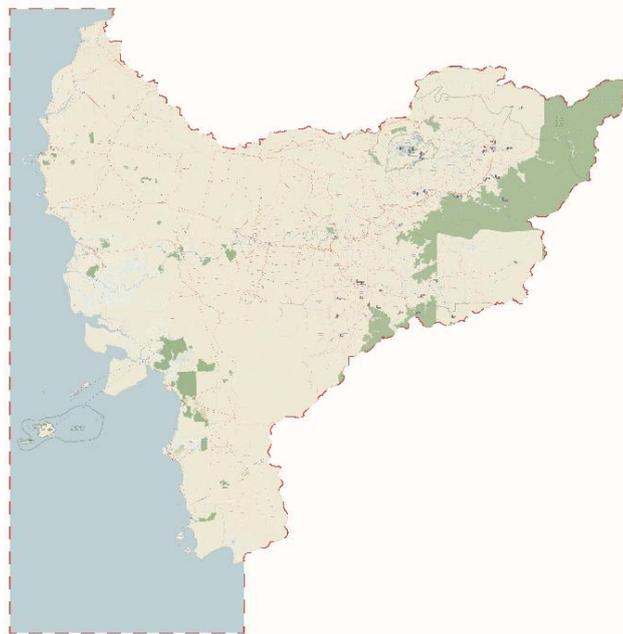
8. A superimposition of network trend analysis with the distribution of tourist attractions will reveal the tendency of tourist attraction distribution towards the road network or ease of access, proximity, connecting points, as well as the most central/main location in the existing interconnectivity

configuration. Finally, the discussion will address the results of the analysis and the centrality which is formed

**RESULTS AND DISCUSSIONS**

**Data and Distribution of Tourist Attractions in West Kalimantan**

Coding of road networks and tourist attractions was performed at the analysis stage. This was done to facilitate the calculation of centrality in the algorithm or software used.



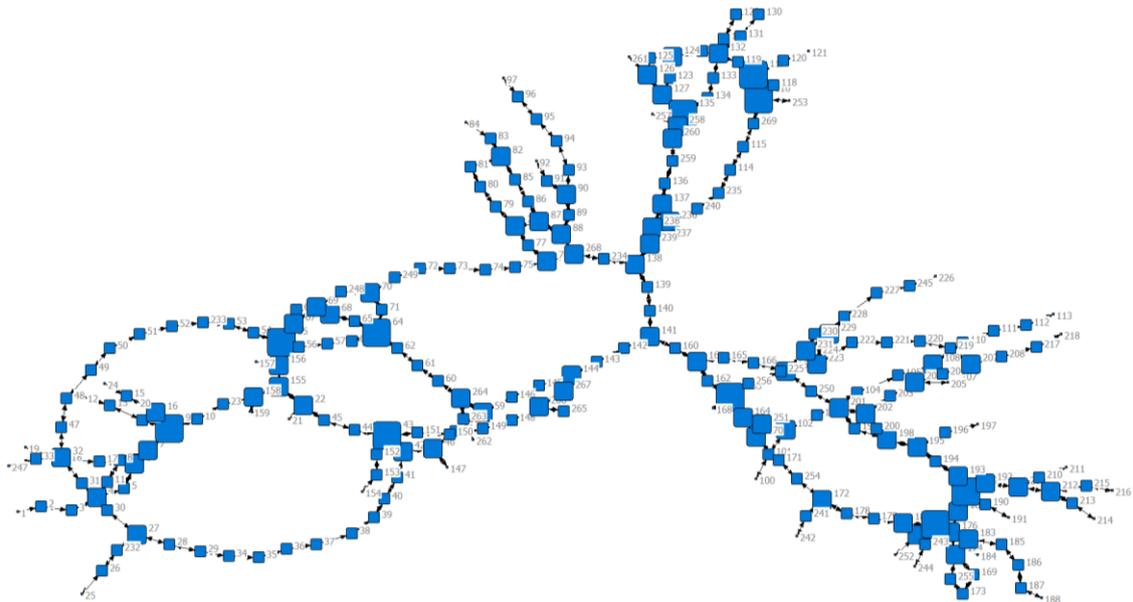
**Figure 2.** Coding the Road Network and Distribution of Tourist Attractions  
 Source: Redrawn Based on Google Earth, 2023

**Pattern and Centralization of Areas Based on Access (Roads)**

Road relationship data (access) were collected from Google Earth and <https://www.openstreetmap.org/>. This data revealed hundreds of relationships between road junctions and tourist attractions. The road network and the distribution of tourist attractions in West Kalimantan were illustrated using Adobe Illustrator, and a different code was assigned to each intersection point and tourist attraction. For the analysis, each intersection was given a code to facilitate the analysis. Tourist attractions were also given different codes to facilitate the calculation and superposition process with the road network (access). The analysis was performed using UCINET software and visualized using NetDraw. The results revealed the following trends in distribution patterns and centrality:

**Degree**

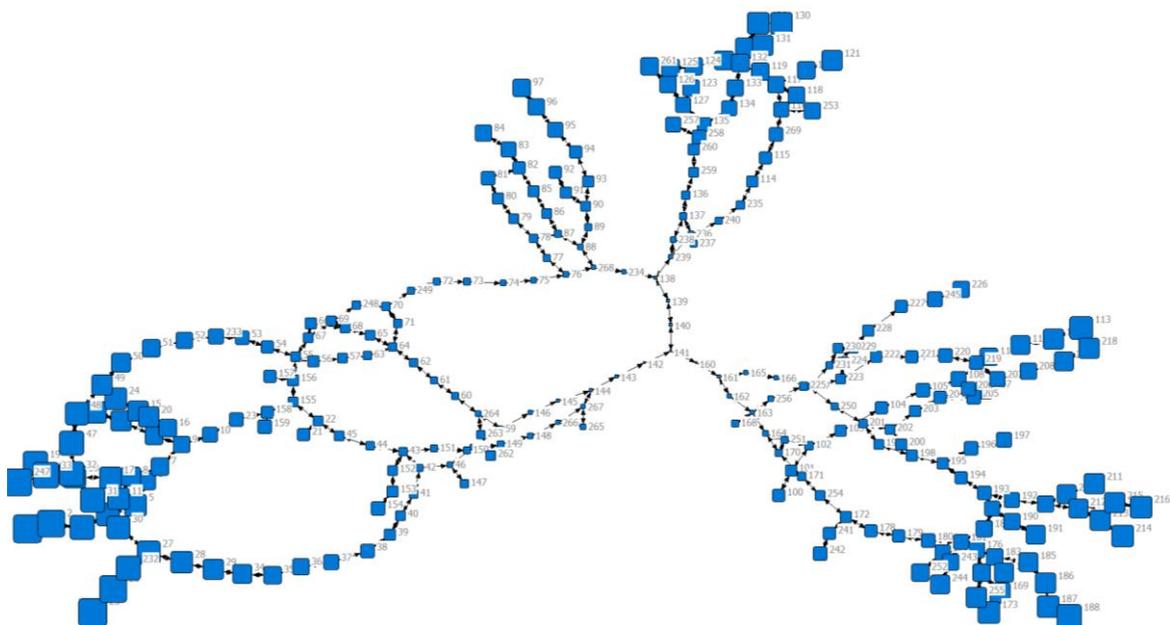
Degree is the number of lines (links) associated with one point, or the number of connections (lines) owned by one point (Borgatti, S et al., 2013; N Scott et al., 2008). Judging from the results of the analysis obtained (Figure 3), the relationship or degree (degree) of the road network (access) in West Kalimantan is generally evenly distributed, with many relationships between points that have the same degree. This can be seen from the NetDraw visualization, which shows dots/nodes of the same average size. However, there are a few points with a significantly larger score or size, namely in the Sambas area (Point No. 9: T-junction Jl. Ahmad Yani – Jl. Raya Karti – Jl. Raya Sepadu), Bengkayang (Point No. 43: Jl. Raya Sanggau Ledo), Mempawah (Point No. 55: Intersection Jl. M. Thaha – Jl. Ahmad Yani – Jl. Raden Kusno – Jl. Gusti M. Taufik & Point No. 64: Intersection Jl. Anjungan – Mempawah – Jl. Anjungan – Bengkayang – Jl. Anjungan - Mandor), Ketapang (Point No. 116: Jl. Brigjen Katamso, Point No. 117: Intersection Jl. Brigadier General Katamso – Jl. D.I. Panjaitan – Jl. Karya Tani – Jl. Letjend S. Parman, & Point No.135: Simpang Tiga Penyiuran), Sanggau (Point No. 163: Intersection Jl. Balai Sebut), Sekadau (Point No. 181: Rawak Hilir – Rawak Hulu), and Sintang (Point No. 189: Simpang Tempunak). The Ketapang area has the most points with the most interactions against other points, namely three points (Point No. 116: Jl. Brigjen Katamso, Point No. 117: Intersection Jl. Brigadier General Katamso – Jl. D.I. Panjaitan – Jl. Karya Tani – Jl. Letjend S. Parman, & Point No.135: Simpang Tiga Penyiuran), all with the same score or size.



**Figure 3.** Road Network (Access) Degree Measurement  
Source: UCINET/NetDraw Analysis, 2023

**Closeness**

Closeness is a measure of how close an actor or point is to all other points in a network. A point is considered central if it can interact quickly with other points (Wasserman & Faust, 1994). Judging from the results of the analysis (Figure 4), the road networks (access) in West Kalimantan are generally closest to several areas, especially in Sambas Regency, Ketapang Regency, Sekadau Regency, Melawi Regency, Sintang Regency, and North Kayong Regency. This can be seen from the score or size of the points in NetDraw, which are the largest. The largest scores or sizes are found in Sambas Regency (point No. 1: T-junction Jl. Abdul Malik - Jl Takam Putih - Jl. Pasir Putih, Point No. 2: T-junction Jl. Pembangunan - Jl. Tawani, Point No. 25: Jl. Ahmad Yani, & Point No. 26: Jl. Ahmad Yani). These results show that several road access points in Sambas Regency have the fastest access from other points.

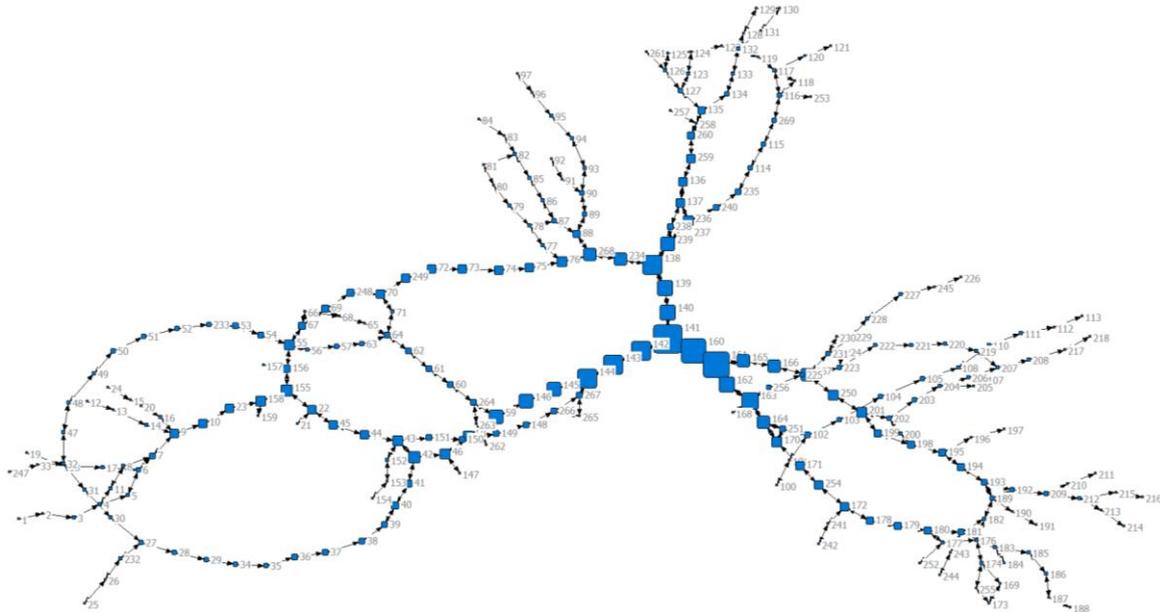


**Figure 4.** Road Network Closeness Measurement (Access)  
Source: UCINET/NetDraw Analysis, 2023

**Betweenness**

Betweenness is a measure of how central an actor or point is in a network by counting the number of shortest paths between other points that pass through the actor or point. A point with a high betweenness is considered a bridge point or flow controller in the network (Borgatti, S et al., 2013; S. Wasserman & Faust, 1994).

Judging from the results of the analysis (Figure 5), the road networks (access) in West Kalimantan generally tend to lead to several areas, especially Sanggau Regency (point No. 141: Intersection Jl. Raya Sosok II - Jl. Barage, & Point No. 161: Intersection Jl. Lintas Malindo - Jl. Balai Sebut). This can be seen based on the score or size visualized NetDraw shows the largest sizes. In addition, these largest sizes are access to meetings from several districts/cities including Pontianak City, Landak Regency, and Ketapang Regency. These results show that several points in the Sanggau Regency are the points that are the liaison between road networks (access) in West Kalimantan.

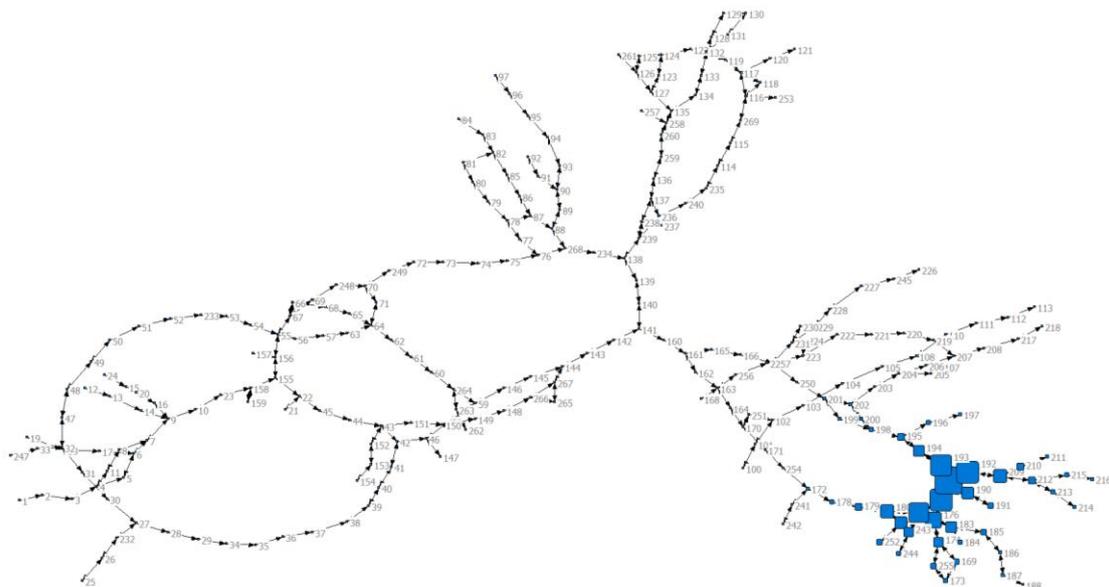


**Figure 5.** Road Network Betweenness Measurement (Access)

Source: UCINET/NetDraw Analysis, 2023

**Eigenvector**

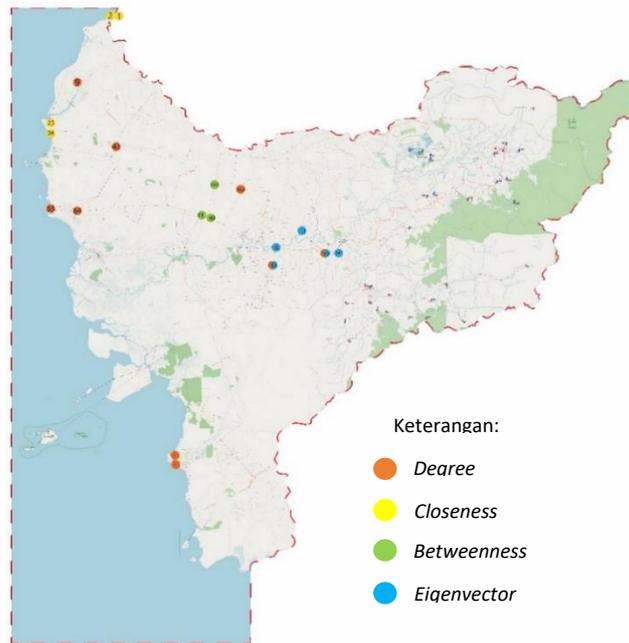
Eigenvector is a measure of the centrality of an actor or point in a network, taking into account the centrality of its neighbors (Borgatti, S, 1995; Borgatti, S et al., 2013; Hanneman, R & Riddle, 2005). Judging from the results of the analysis (Figure 6), the road networks (access) in West Kalimantan are generally most central to several areas, especially in Sintang Regency (point No. 189: Simpang Tempunak, Point No. 191: Entabuk, & Point No. 192: Tugu Karet Simpang Pinoh) and Sekadau Regency (point No. 181: Rawak Hilir - Rawak Hulu & 182: Intersection Jl. Pangeran Limboro). This can be seen from the score or size of the points in NetDraw, which are the largest. These results show that several points in West Kalimantan, namely in Sintang Regency and Sekadau Regency, are the most central points in terms of overall network structure.



**Figure 6.** Eigenvector Road Network Measurement (Access)

Source: UCINET/NetDraw Analysis, 2023

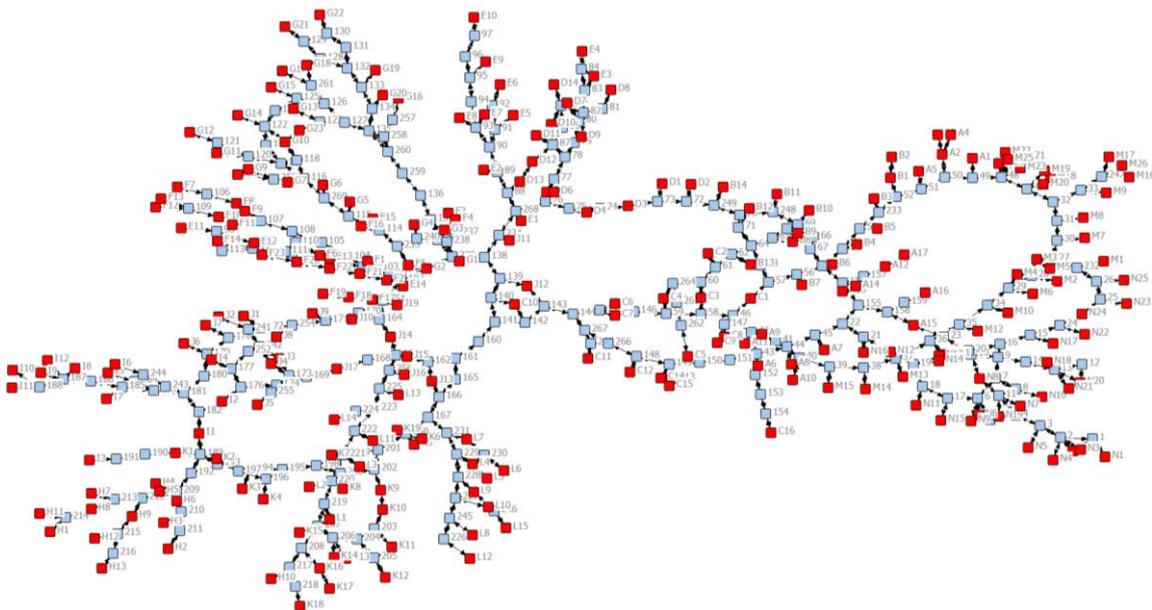
The following is a thematic map of the pattern and attachment to the area based on access (roads) of West Kalimantan based on the analysis that has been conducted.



**Figure 7.** Thematic Map of Regional Patterns and Centerization Based on Access (Road) in West Kalimantan  
Source: Author Analysis, 2023

**Patterns Of Tourist Attraction Access to Roads**

This section presents a superposition analysis of the road network (access) and tourist attraction data in West Kalimantan. Tourist attractions are connected directly to the intersections (nodes) that are directly related to existing tourist attractions. The relationship between the road network (access) and the distribution of tourist attractions is shown in Figure 8.

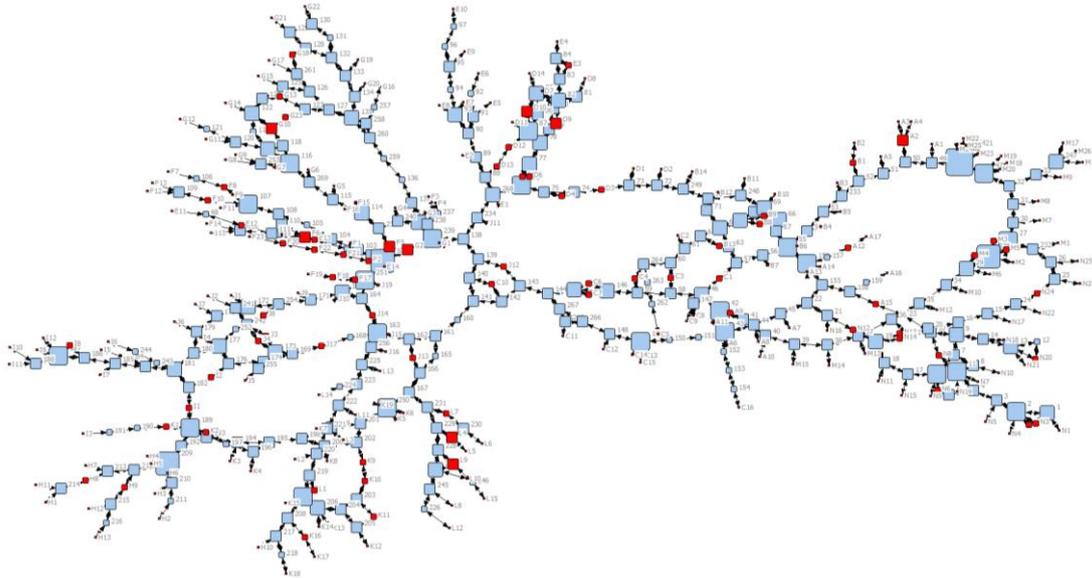


**Figure 8.** Superimpose Road Network (Access) with Tourist Attraction Distribution (in red)  
Source: UCINET/NetDraw Analysis, 2023

**Degree**

Figure 9 shows that the degree (number of connections) between road networks and tourist attractions in West Kalimantan is generally evenly distributed across all districts/cities in the province. This is evident from the

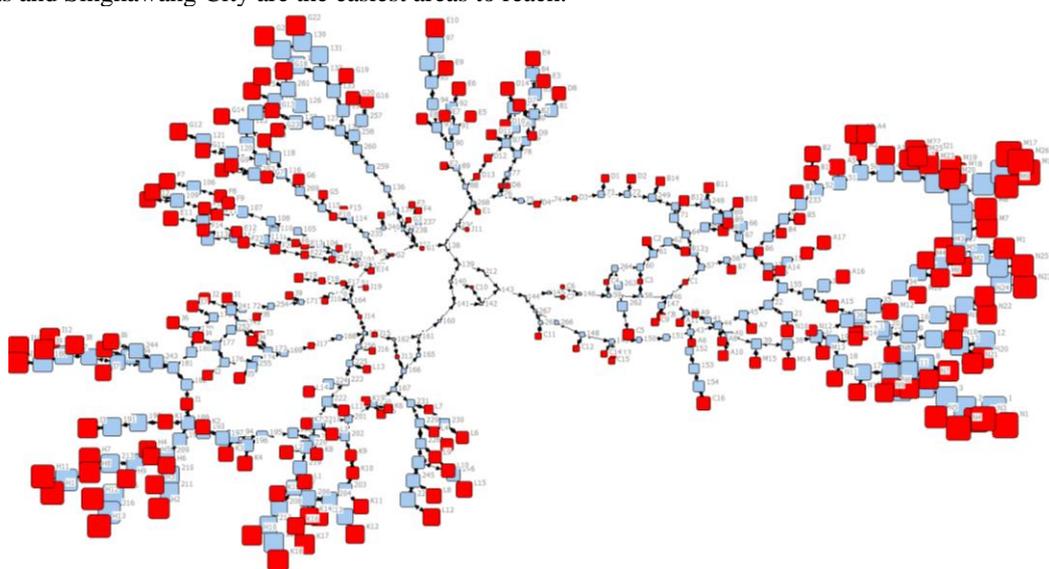
score or size of the points/nodes in NetDraw (larger points indicate a higher degree). The tourist attractions with the highest degree scores/sizes are A2 (Mimiland Batu Payung, Bengkayang Regency), D9 (Church Santo Yosef Cathedral, Pontianak City), D10 (Masjid Raya Mujahidin, Pontianak City), F5 (Taman Nasional Gunung Palung, North Kayong Regency), F6 (Air Paoh, North Kayong Regency), G2 (Taman Nasional Gunung Palung, Ketapang Regency), G10 (Rumah Adat Dayak Kabupaten Ketapang), L4 (Danau Sekawi, Kapuas Hulu Regency), and L9 (Danau Mupa Kencana, Kapuas Hulu Regency). These attractions have the most interactions with road networks (access) or other tourist attractions.



**Figure 9.** Degree Measurement of Access and Distribution of Tourist Attractions in West Kalimantan  
Source: UCINET/NetDraw Analysis, 2023

**Closeness**

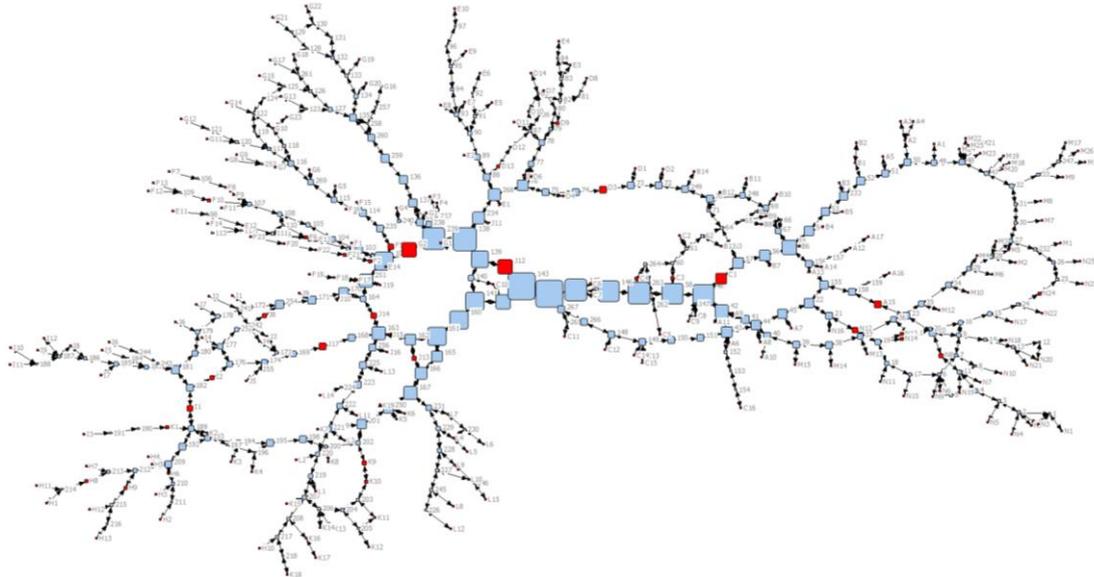
Figure 10 shows that the closeness (ability to be accessed quickly) between road networks and tourist attractions in West Kalimantan is generally evenly distributed across all districts/cities in the province. This is evident from the score or size of the points/nodes in NetDraw (larger points indicate higher closeness). Judging from the score or largest size visualized by NetDraw, the tourist attractions with the highest closeness scores/sizes are: N1 (Telok Atong Bahari, Sambas Regency), N2 (Dermaga Temajuk, Sambas Regency), N4 (Pantai Camar Bulan, Sambas Regency), M16 (Gunung Pasi, Singkawang City), M17 (Taman Agrowisata Bukit Bougenville, Singkawang City), M26 (Danau Sarantangan, Singkawang City). These attractions are closest to other points and can therefore be accessed quickly from within the region. These results indicate that some tourist attractions in Sambas and Singkawang City are the easiest areas to reach.



**Figure 10.** Closeness Measurement of Access and Distribution of Tourist Attractions in West Kalimantan  
Source: UCINET/NetDraw Analysis, 2023

**Betweenness**

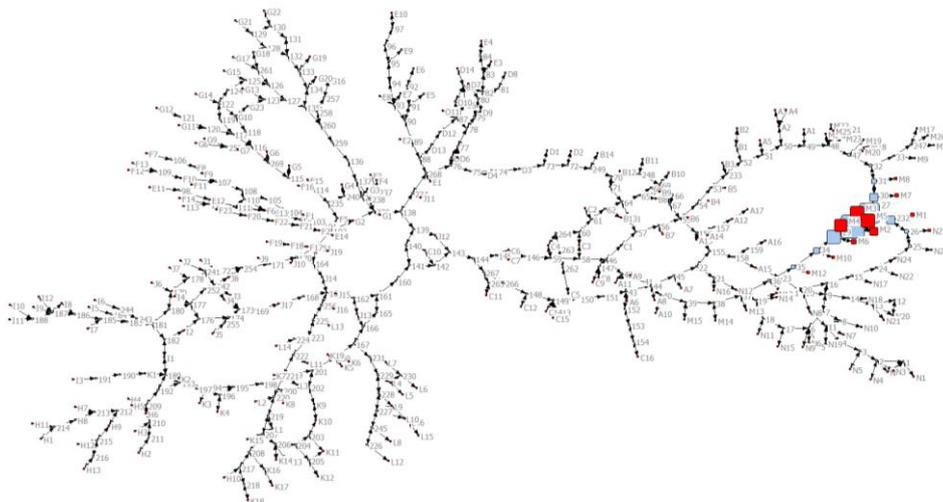
Figure 11 shows that the betweenness (importance as a bridge between other points) of road networks is generally much higher than that of tourist attractions in West Kalimantan. This is evident from the score or size of the points/nodes in NetDraw (larger points indicate higher betweenness). The points with the highest betweenness scores/sizes are 143 and 144, which are located on the Jalan Kalimantan Poros Tengah, a connecting road between Landak Regency and Sanggau Regency. These points serve as a "hub" in the road network, connecting many different areas. Tourist attractions have a lower impact on the overall betweenness of the network, but the highest betweenness scores/sizes among tourist attractions are found at: J12 (Gunung Tiong Kandang, Sanggau Regency), and G2 (Taman Nasional Gunung Palung, Ketapang Regency). These attractions are located on important roads that connect many other areas, which gives them a relatively high betweenness score/size.



**Figure 11.** Betweenness Measurement of Access and Distribution of Tourism Attractions in West Kalimantan  
Source: UCINET/NetDraw Analysis, 2023

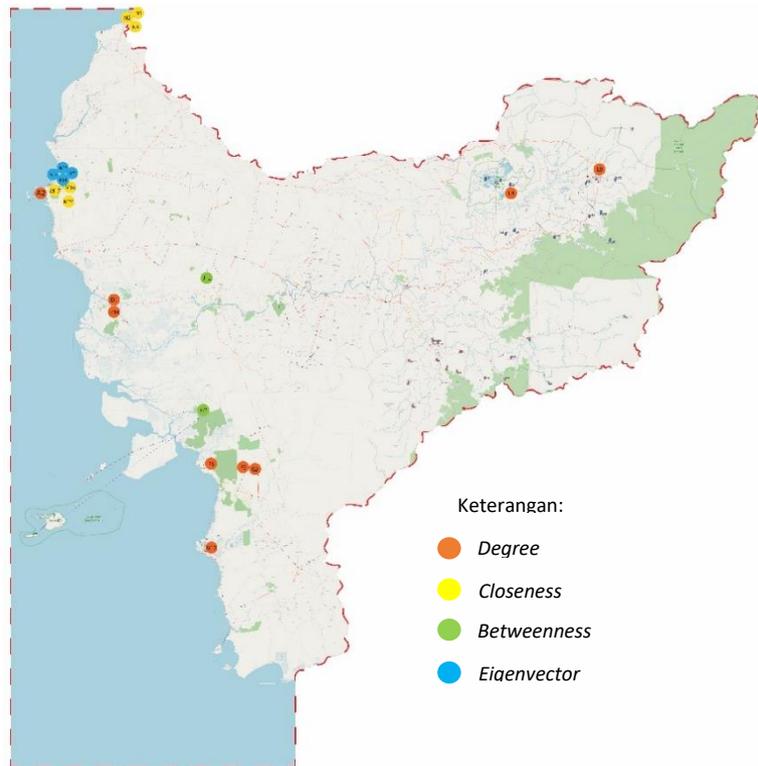
**Eigenvector**

Figure 12 shows the eigenvector centrality (importance relative to other nodes) of road networks and tourist attractions in West Kalimantan. The points/nodes with the largest scores/sizes are the most central points in the network. The most central point in the network is in Singkawang City, with the largest score/size marked by points number 27 and 28. The most central tourist attractions are: M2 (Taman Burung Singkawang), M3 (Masjid Raya Singkawang), M4 (Bangunan Cagar Budaya Marga Tjhia), M5 (Vihara Tri Dharma Bumi Raya). These results indicate that Singkawang City is a central point in the configuration of the distribution of tourist attractions in West Kalimantan.



**Figure 12.** Eigenvector Measurement of Access and Distribution of Tourism Attractions in West Kalimantan  
Source: UCINET/NetDraw Analysis, 2023

The following is a thematic map of the pattern and attraction of tourist attractions on access (roads) of West Kalimantan based on the analysis that has been conducted.



**Figure 13.** Thematic Map of Patterns and Centralization of Tourism Attractions on Access (Road) in West Kalimantan

Source: Author Analysis, 2023

### Patterns of Tourist Attractions In West Kalimantan

Based on the analysis results, the following patterns and attractions of tourist attractions in West Kalimantan can be summarized: degree, closeness, betweenness, and eigenvectors. Degree measures the number of connections between nodes. The average node as visualized by NetDraw in West Kalimantan has a similar number of connections, but there are a few nodes in certain areas that have a large number of connections to other nodes. These nodes are evenly distributed throughout the region. Closeness measures how easy it is to reach other nodes from a given node. On average, each node in West Kalimantan is easily accessible from other nodes. However, there are a few regions, such as Sambas Regency, Ketapang Regency, Sekadau Regency, Melawi Regency, Sintang Regency, and North Kayong Regency, that have a higher number of nodes that are easily accessible from other nodes. Betweenness measures the importance of a node in connecting other nodes. Sanggau Regency (point No. 141: Intersection Jl. Raya Sosok II, point No. 160: T-junction Jl. Raya Sosok II - Jl. Barage, & Point No. 161: Intersection Jl. Lintas Malindo - Jl. Balai Sebut) is the most important node in the road network of West Kalimantan, as it is a meeting point for several other districts and cities in West Kalimantan, namely Pontianak City, Landak Regency, and Ketapang Regency. Eigenvectors measure the centrality of a node in the network. The most central nodes in the road network of West Kalimantan are located in Sintang Regency and Sekadau Regency.

The following tourist attractions in West Kalimantan have the highest level of relationship or interaction with the road network and other tourist attractions: Mimiland Batu Payung (Bengkayang Regency), Gereja Katedral Santo Yosef (Pontianak City), Masjid Raya Mujahidin (Pontianak City), Taman Nasional Gunung Palung (North Kayong Regency), Air Paoh (North Kayong Regency), Taman Nasional Gunung Palung (Ketapang Regency), Rumah Adat Dayak Kabupaten Ketapang, Danau Sekawi (Lake Sekawi (Kapuas Hulu Regency), and Danau Mupa Kencana (Kapuas Hulu Regency). These attractions were identified based on a measurement of the relationship between road networks and tourist attractions in West Kalimantan.

The closeness of road networks and tourist attractions in West Kalimantan is generally similar in each district/city region. However, there are a few tourist attractions that have a higher closeness than others as indicated by the colors, meaning that they are more easily accessible from other tourist attractions and road networks. These attractions include: Teluk Atong Bahari (Sambas Regency), Dermaga Temajuk (Sambas Regency), Pantai Camar Bulan (Sambas Regency), Gunung Pasi (Kota Singkawang), Taman Agrowisata Bukit

Bougenville (Singkawang City), and Danau Sarantangan (Singkawang City). These attractions are indicated by the size of the point/node in NetDraw, where a larger size indicates a higher closeness. The results of the analysis indicate that tourist attractions become points with ease of access or achievement to other points. This means that tourists can easily get to these attractions from other tourist attractions or road networks.

The road network in West Kalimantan is generally more central than the tourist attractions, meaning that it is better connected between regions and tourist attractions. The road connecting Landak Regency and Sanggau Regency, Jalan Kalimantan Poros, is a particularly important hub. However, the highest centrality scores are found at two points: J12 (Gunung Tiong Kandang, Sanggau Regency), and G2 (Taman Nasional Gunung Palung, Ketapang Regency). These points are important because they connect many different regions and tourist attractions.

The city of Singkawang has the highest centrality score for tourist attractions in West Kalimantan. The following tourist attractions in Singkawang have the highest centrality scores: M2 (Taman Burung Singkawang), M3 (Masjid Raya Singkawang), M4 (Bangunan Cagar Budaya Marga Tjhia), M5 (Vihara Tri Dharma Bumi Raya). These results indicate that Singkawang is a central point in the distribution of tourist attractions in West Kalimantan.

**Table 2.** Trends in the Pattern and Centering of West Kalimantan Tourism Attractions Based on Network Analysis

Analysis	Degree	Closeness	Betweenness	Eigenvector
Pattern and centralization of areas based on access (roads)	<b>Ketapang Regency</b> - Point No. 116 (Jl. Brigjen Katamso) - Point No. 117 (Perempatan Jl. Brigjen Katamso – Jl. D.I. Panjaitan – Jl. Karya Tani – Jl. Letjend S. Parman) - Point No. 135 (Simpang Tiga Penyiuran)	<b>Sambas Regency</b> - Point No. 1 (T-Junction Jl. Abdul Malik – Jl Takam Putih – Jl. Pasir Putih) - Point No. 2 (T-Junction Jl. Pembangunan – Jl. Tawani) - Point No. 25 (Jl. Ahmad Yani) - Point No. 26 (Jl. Ahmad Yani)	<b>Sanggau Regency</b> - Point No. 141 (Intersection Jl. Raya Sosok II) - Point No. 160 (T-Junction Jl. Raya Sosok II – Jl. Barage) - Point No. 161 (Intersection Jl. Lintas Malindo – Jl. Balai Sebut)	<b>Kabupaten Sintang</b> - Point No. 189 (Simpang Tempunak) - Point No. 191 (Entabuk) - Point No. 192 (Tugu Karet Simpang Pinoh)
	Patterns of Tourist Attraction Access to Roads	<b>Bengkayang Regency</b> - Mimiland Batu Payung (A2) <b>Pontianak City</b> - Gereja Katedral Santo Yosef (D9) - Masjid Raya Mujahidin (D10) <b>Kayong Utara Regency</b> - Taman Nasional Gunung Palung (F5) - Air Paoh (F6) <b>Ketapang Regency</b> - Taman Nasional Gunung Palung (G2) - Rumah Adat Dayak	<b>Sambas Regency</b> - Telok Atong Bahari (N1) - Dermaga Temajuk (N2) - Pantai Camar Bulan (N4) <b>Singkawang Regency</b> - Gunung Pasi (M16) - Taman Agrowisata Bukit Bougenville (M17) - Danau Sarantangan (M26)	<b>Sanggau Regency</b> - Gunung Tiong Kandang (J12) <b>Ketapang Regency</b> - Taman Nasional Gunung Palung (G2)

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Kabupaten  
Ketapang (G10)

**Kapuas Hulu  
Regency**

- Danau Sekwai  
(L4)  
- Danau Mupa  
Kencana (L9)

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Source: Author Analysis, 2023

## CONCLUSIONS

Tourism is a major driver of economic development in many regions. The presence of tourist attractions and their accessibility are important factors for tourists when choosing a destination. Therefore, it is important to improve transportation networks and integrate infrastructure networks between tourist attractions to maximize their potential. This study identifies and analyzes the road network (access) and its relationship with tourist attractions in West Kalimantan to assess the existing connectivity. The distribution of access points and tourist attractions is examined using a network analysis consisting of degree, closeness, betweenness, and eigenvector calculations.

The results show that the road network (access) in West Kalimantan has different connectivity levels in different areas. The Sambas Regency has the highest number of interactions (degree). The Ketapang Regency has the highest ease of access (closeness). The Sanggau Regency is the central hub of the road network in West Kalimantan (betweenness). The most central points in the road network configuration are in the Sintang and Sekdau Regencies (eigenvector). When the road network (access) and the distribution of tourist attractions are analyzed together, it is found that tourist attractions are evenly distributed in each region. However, there are a few areas with a higher concentration of tourist attractions with high connectivity to the road network. These areas include Bengkayang Regency, Pontianak City, North Kayong Regency, Ketapang Regency, and Kapuas Hulu Regency.

In terms of closeness, some tourist attractions in the Sambas and Singkawang Regencies are the easiest to access in West Kalimantan. However, overall, tourist attractions are evenly distributed in each district/city. The road network is dominant in the centralization (betweenness) and acts as a connecting bridge between regions. The road that connects the Landak Regency with Sanggau Regency is a key link in the overall network. The central point (eigenvector) in the configuration of tourist attractions in West Kalimantan is in the Singkawang City.

The implication of the research findings is that policymakers need to consider further clusters of tourist attractions that can be formed to create patterns that facilitate development, connectivity and markets to be developed. In addition, priority development "clusters" can also be developed. This can be done considering the number of tourist attractions that need to be managed and financed. In this way, West Kalimantan can gradually find the appropriate pattern of development from the point of view of the hierarchy of centrality or centeredness.

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