



Geographic Information System (GIS) Application to Identify the Distribution of Tourist Attractions and Supporting Facilities Related to the Sustainable Development Goals (SDGs)

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ABSTRACT

The purpose of this research is to examine the distribution patterns of tourism attractions, hotels, and restaurants, and to explore their implications for achieving the Sustainable Development Goals (SDGs) in Lembang District. To analyze these distributions, a quantitative approach was applied using nearest neighbor analysis and Geographic Information System (GIS) techniques. A total of 38 tourism attractions were identified, including 17 natural attractions, 17 artificial attractions, and four cultural attractions; all exhibiting dispersed distribution patterns. There are 32 hotels with random distribution patterns and 178 restaurants that are clustered. Natural attractions are characterized by hilly terrain, forests, valleys, and rivers, which result in physical separation between some sites. In contrast, artificial and cultural attractions tend to be concentrated in more accessible areas, particularly along main routes. Notably, villages such as Cikahuripan, Cikidang, Mekarwangi, Suntenjaya, Wangunharja, and Wangunsari contain tourism attractions but lack adequate supporting facilities, including hotels and restaurants. The spatial allocation of tourism attractions, accommodations, and restaurants significantly influences the achievement of the SDGs. Tourism contributes to 14 of the 17 SDGs, especially SDG 8 (promoting economic opportunities), SDG 1 (reducing poverty), and SDG 5 (advancing gender equality).

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1. INTRODUCTION

The growth of the tourism industry is considered a strategic asset that can benefit local communities and promote development in areas with potential tourist attractions. Many reports regarding tourism have been well-documented [1-8]. Tourism influences social aspects, such as job creation, as well as cultural and economic dimensions, including foreign exchange and tax revenues, making it a lucrative industry and a promising source of income for towns surrounding tourist sites. Developing tourism as a green and sustainable industry requires a multidimensional approach that integrates economic, social, and environmental factors [9].

One region in Indonesia experiencing rapid tourism growth in recent years is West Bandung Regency, particularly Lembang District. This district is renowned for its unique and captivating natural charm, featuring beautiful mountains, a cool climate, and breathtaking panoramas. Lembang also offers a variety of tourist attractions, including parks, tea plantations, waterfalls, and recreational areas, drawing both local and international visitors. Lembang District has substantial potential to enhance the economic well-being of its residents through tourism development. The district hosts a total of 38 tourist attractions, classified into natural, cultural, and artificial categories. Ownership of these attractions is largely dominated by the private sector, reflecting Lembang's unique appeal that encourages investors to establish tourism businesses, supported by the West Bandung Regency government. The tourism industry in Lembang has had a significant impact on the local economy, particularly benefiting farmers, which underscores the need for sustainable tourism infrastructure that balances visitor satisfaction, environmental preservation, and community well-being.

Developing Lembang as a tourism destination using a spatial approach has produced spatial elements that reflect the region's distinctive characteristics. These elements can support the development of sustainable tourism destinations and can be applied in regional planning for tourism both in Indonesia and internationally, adapted to local characteristics, tourist markets, and government policies.

Lembang District offers significant potential, including diverse agro-tourism attractions that leverage its natural beauty. However, challenges exist, such as land conversion from agriculture to tourism, which can impact agricultural sustainability and require careful planning to balance development with environmental preservation [10]. Other potential includes scenic pine forests and a community-driven approach to spiritual tourism. Challenges in this area involve limited human resources, the need for effective program management, and the engagement of experienced consultants to enhance spiritual tourism offerings and infrastructure [11].

As tourist numbers and destinations grow, the availability and distribution of supporting facilities become increasingly crucial. Accommodations, restaurants, souvenir shops, information centers, and other amenities must be adequately and evenly distributed to support tourism activities. Uneven distribution can cause inconvenience to visitors and underutilize economic potential. Some areas lack sufficient facilities, while others are overloaded, leading to economic disparities across Lembang District. This situation highlights the need for integrated tourism planning to ensure that facilities are available and distributed to meet tourist needs. Analyzing the distribution of tourism and supporting facilities can guide decisions and strategies for developing Lembang District as a tourist destination. Therefore, to foster organized, equitable, and sustainable tourism development, this study aims to examine the distribution patterns of tourist attractions,

accommodations, and restaurants and assess their contributions to achieving the Sustainable Development Goals (SDGs).

2. LITERATURE REVIEW

2.1. GIS Application for the Distribution of Tourism Objects and Their Facilities

Geographic Information Systems (GIS) can assess infrastructure impacts, estimate visitor numbers, and provide recommendations to enhance tourism services, thereby increasing the attractiveness and competitiveness of tourist destinations [12]. GIS also supports tourism planning and management by mapping resources, predicting visitor flows, evaluating environmental impacts, and enabling customized itineraries. This ensures sustainable tourism development that benefits local communities and preserves cultural heritage, while also promoting stakeholder engagement, community-based planning, and risk management [13]. Additionally, GIS aids tourism planning by processing and analyzing data on tourist attractions, integrating knowledge from various fields, and facilitating faster decision-making, as demonstrated in Egypt [14]. As a strategic planning tool, GIS enhances tourism development by visualizing spatial distributions and supporting informed decisions, especially in countries with established GIS applications [15]. Overall, GIS positively influences sustainable tourism management by improving decision-making, protecting resources, and contributing to theoretical advancements that foster innovation in smart tourism [16].

2.2. Research Related to The Distribution of Tourism Objects and Sustainable Development Goals

Research on the distribution of tourism attractions, hotels, and restaurants plays a crucial role in achieving the SDGs by promoting economic growth and job creation within local communities. Equitable distribution of tourism infrastructure can empower marginalized communities, as sustainable tourism practices contribute to environmental preservation and cultural understanding. Strategic planning allows stakeholders to maximize benefits, ensuring that tourism positively impacts SDGs such as poverty alleviation, gender equality, and access to health services, ultimately fostering a sustainable future. The spatial distribution of tourism attractions, hotels, and restaurants is vital for sustainable tourism development. By encouraging eco-friendly travel practices, developing environmentally responsible accommodations, and supporting local economies, these facilities can reduce environmental impacts while preserving cultural heritage. The growing focus on sustainable tourism promotes investment in responsible practices, in line with the Sustainable Tourism Criteria established by organizations such as the Global Sustainable Tourism Council.

2.2. Sustainable Tourism Implementation in West Bandung Regency and Lembang District

Lembang District, which accounts for 36.58% of the tourist attractions in West Bandung Regency, has initiated programs to promote sustainable tourism, such as developing tourism villages under the PNPM Mandiri program. This initiative aims to reduce poverty by involving local communities in tourism activities [18]. The district holds significant potential for tourism development through nature-based attractions and cultural practices; however, high poverty rates present challenges. For sustainable tourism, strategies targeting educational institutions are essential to stimulate tourism growth [19].

Tourism promotion in Lembang District takes various forms, including social media campaigns and tourism events, which have evolved in line with technological advancements and tourist preferences. These promotional efforts indicate positive prospects for tourism

development and its economic impact in the region [20]. The growth of tourism in Lembang has notably influenced the local economy, particularly benefiting farmers. Consequently, sustainable tourism infrastructure is needed to balance visitor satisfaction, environmental preservation, and the well-being of the local community.

3. METHOD

The research was conducted in Lembang District, West Bandung Regency, from January to May 2024. The study employed direct observation and secondary data collection. Data gathered included the names and types of tourist attractions, as well as the coordinates of all tourist attractions, hotels, and restaurants. Distribution patterns were analysed using nearest neighbor analysis through ArcGIS software. Nearest neighbour analysis is a method used to evaluate point distribution patterns in spatial data. The formula is in Equation (1):

$$NNI = \frac{\bar{D}(Obs)}{0.5 \sqrt{\frac{a}{n}}}, \tag{1}$$

Where NNI is the nearest neighbor index, $\bar{D}(Obs)$ is the average distance to the nearest neighbor, a is the total area, and n is the the number of objects under examination.

4. RESULTS AND DISCUSSION

4.1. Distribution of Tourism Attractions and Supporting Facilities in Lembang District, West Bandung Regency

A total of 38 tourist attractions were identified in Lembang District. The seventeen natural attractions exhibit a dispersed distribution pattern. Similarly, the seventeen artificial attractions also display a dispersed pattern, as do the four cultural attractions. **Figure 1** and **Table 1** illustrate the distribution of tourist attractions in Lembang District, West Bandung Regency. **Figures 2** and **3**, along with **Table 2**, present the distribution of hotels and restaurants in the district.

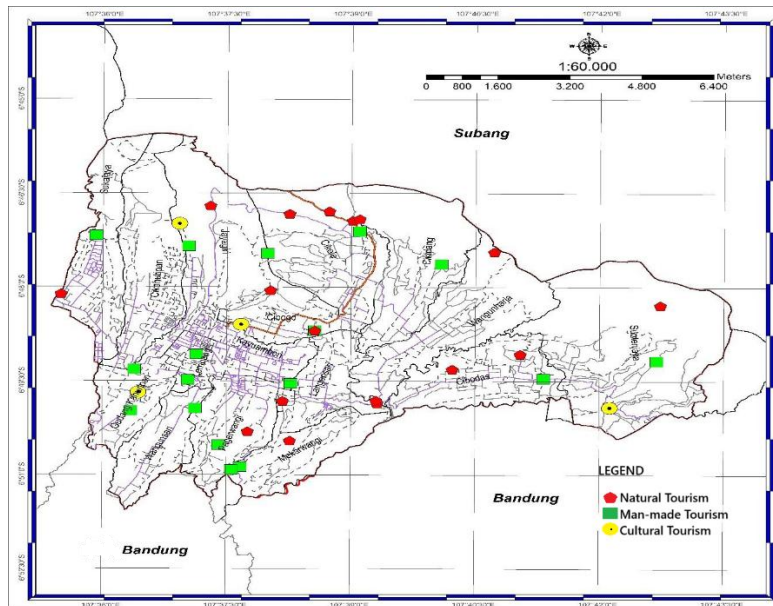


Figure 1. The distribution map of tourism attractions in Lembang district, West, Bandung regency.

Table 1. Pattern of distribution of tourism attractions in Lembang District, West Bandung Regency.

No	Tourism Type	Number of Sites	Average of nearest neighbor (meters)	Nearest Neighbor Index (NNI)	Pattern of distribution of tourism objects
1	Natural Tourism	17	1104.5	1.27	Dispersed
2	Man-made Tourism	17	1122.5	1.27	Dispersed
3	Cultural Tourism	4	1811.2	2.47	Dispersed

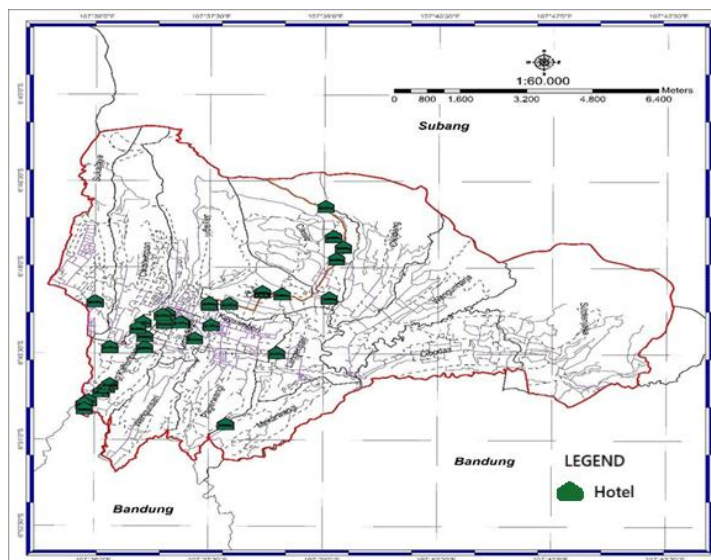


Figure 2. The distribution map of supporting facilities of tourism (hotel) in Lembang District, West Bandung Regency.

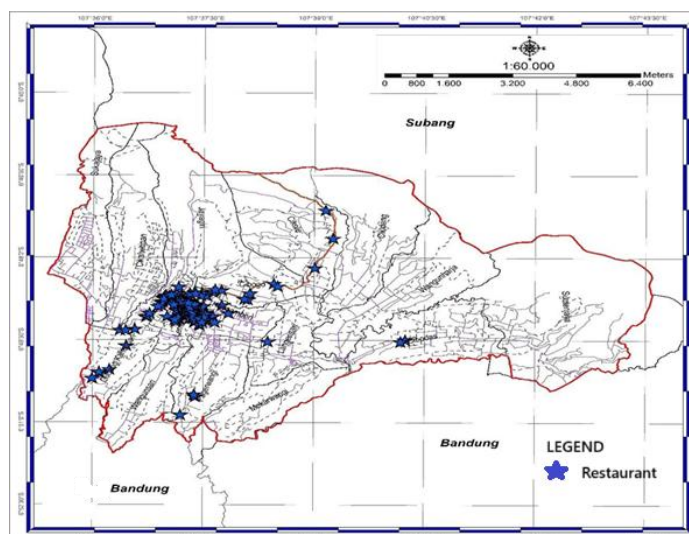


Figure 3. The distribution map of supporting facilities of tourism (Restaurant) in Lembang District, West Bandung Regency.

Table 2. Pattern of distribution of supporting facilities of tourism in Lembang District, West Bandung Regency.

No	Type of Supporting Facilities in Tourism	Number of sites (points)	Average of nearest neighbor (meters)	Nearest Neighbor Index	Pattern of distribution of tourism objects
1	Hotel	32	492.8	0.86	Random
2	Restaurant	178	75.32	0.33	Clustered

Based on **Table 3**, Gudangkahuripan Village has the highest number of hotels, with eight units. Lembang Village has seven hotels, Cikole Village has six, and Jayagiri Village has four. The villages of Cibodas, Cikahuripan, Cikidang, Mekarwangi, Suntenjaya, Wangunharja, and Wangunsari do not have any hotels. In terms of restaurants, Lembang Village has the highest number, with 103 establishments. Kayuambon Village ranks second with 33 restaurants, followed by Jayagiri Village with 17. The villages of Cikahuripan, Cikidang, Mekarwangi, Sukajaya, Suntenjaya, Wangunharja, and Wangunsari do not have any restaurants.

Table 3. Number of Tourism Attractions, Restaurants, and Hotels in the Villages of Lembang District, West Bandung Regency.

No	Villages	Number of Tourism Attractions (sites)			Number of Restaurants (units)	Number of Hotels (units)
		Natural Tourism	Man-made Tourism	Cultural Tourism		
1	Cibodas	3	1	-	2	0
2	Cibogo	-	1	1	8	3
3	Cikahuripan	-	1	1	0	0
4	Cikidang	-	1	-	0	0
5	Cikole	5	1	-	3	6
6	Jayagiri	2	1	-	17	4
7	Kayuambon	-	1	-	33	1
8	Langensari	2	1	-	1	1
9	Lembang	-	2	-	103	7
10	Mekarwangi	1	1	-	0	0
11	Pagerwangi	1	2	-	3	1
12	Sukajaya	1	1	-	0	1
13	Suntenjaya	1	1	1	0	0
14	Wangunharja	1	-	-	0	0
15	Wangunsari	-	1	-	0	0
16	Gudang Kahuripan	-	1	1	8	8
Total		17	17	4	178	32

Tourist attractions in North Lembang are predominantly natural, with seven notable sites, including Orchid Forest, Puncak Jayagiri, and Bandung Treetop. The North Lembang area is classified as an ecotourism destination, a theme shared with East Lembang. East Lembang's attractions are also nature-focused, featuring seven sites such as Curug Maribaya, The Lodge

Maribaya, and Mount Batu. In contrast, South Lembang's attractions are mainly artificial, making them popular for family tourism. Key sites include Farmhouse Lembang, Dago Theme Park, and Lawang Wangi Creative Space Cafe. West Lembang is similarly dominated by artificial attractions, with the advantage of being close to Bandung City. Notable attractions include the Bosscha Observatory, De'Ranch, and Floating Market Lembang. Both South and West Lembang are well-suited for tourism with recreational and educational themes.

4.2. Distribution of Tourism Attractions, Supporting Facilities, and Implications in Achieving SDGs

Natural tourist attractions in Lembang District are scattered and irregularly distributed due to the varied geographical and topographical conditions, with many sites located in remote and pristine areas. While this scattered arrangement offers visitors a more intimate experience with nature, it also poses challenges for accessibility.

In contrast, the distribution of hotels in Lembang District tends to be more random. Although some concentrations exist near popular tourist attractions, such as the Floating Market, many hotels have been developed in areas not directly adjacent to these attractions. This random pattern occurs because hoteliers aim to meet broader market demand by establishing facilities in locations deemed strategic, even if they are not immediately close to major tourist sites.

Although the dispersed arrangement of natural attractions offers a more serene and immersive experience, it can also limit visitor numbers due to challenging accessibility. While hotels are not always located close to these attractions, their uneven distribution provides tourists with a range of accommodation options to suit their needs. Developing effective strategies to enhance accessibility, visitor satisfaction, and overall economic impact requires a clear understanding of these spatial patterns.

These research findings align with previous studies on the role of tourism in achieving the SDGs by promoting inclusive economic growth and social inclusiveness. Properly managed tourism infrastructure can strengthen local economies, preserve cultural and natural assets, and support environmental sustainability. Equitable access to tourism resources allows stakeholders to mobilize efforts, celebrate diverse cultural heritage, and foster social cohesion, thereby contributing to the broader objectives outlined in the 2030 Agenda for Sustainable Development [21].

The relationship between tourism and the SDGs indicates that understanding this interplay can guide sustainable tourism practices. Insights from this study can inform the distribution and management of tourism-related entities to better align with the SDGs. Tourism contributes significantly to 14 of the 17 SDGs, particularly SDG 1, SDG 2, SDG 3, SDG 5, SDG 10, and SDG 16. Achieving these goals involves promoting responsible tourism practices and increasing public awareness to ensure that tourism development maximizes positive impacts while minimizing adverse effects on other SDGs.

The tourism industry has the potential to support SDGs through its connections at both local and regional levels. The distribution of tourist attractions, hotels, and restaurants plays a key role in addressing challenges such as poverty and inequality. By strategically locating these facilities, tourism can strengthen local economies, promote environmental sustainability, and advance social equity. This alignment with the SDGs emphasizes the responsibility of the tourism sector to generate positive impacts at both local and global scales.

The distribution of tourist attractions, hotels, and restaurants plays a significant role in achieving the SDGs, requiring stakeholders to collaborate in addressing challenges associated with sustainable tourism practices. By promoting equitable distribution and

responsible management of tourism resources, the industry can strengthen local economies, reduce environmental impacts, and encourage community engagement. Similarly, research on Pacific Island Countries and Territories (PICTs) shows that the distribution of tourism attractions, hotels, and restaurants has a substantial effect on SDG achievement. While the growth of tourism infrastructure can lead to environmental challenges such as coastal erosion and biodiversity loss, fostering community-based tourism and partnerships can enhance local economies and food security, supporting SDGs related to poverty reduction and responsible consumption [22].

The distribution of tourist attractions, including hotels and restaurants, has a significant impact on local well-being and sustainable development. Integrating people experiencing poverty into the tourism value chain (SDG 1) is essential for promoting equitable income distribution (SDG 10) [23]. Research in Bali has demonstrated links between five-star hotels and the SDGs through various initiatives. For example, Hotel A supports local employment and social security (SDG 1), while Hotel B emphasizes Corporate Social Responsibility programs. The distribution of tourist attractions, hotels, and restaurants can strengthen local economies and enhance social welfare, advancing SDGs related to poverty alleviation, health, education, and gender equality. This underscores the hospitality sector's potential to drive sustainable development in tourism destinations [25]. Finally, this study adds new information regarding SDGs, as reported in **Table 4**.

Table 4. Previous studies on SDGs.

No	Title	Reference
1	Dataset on the number of schools, teachers, and students in Sulawesi, Indonesia: kindergarten, primary, junior, senior high, vocational, and Islamic boarding schools with educational access, quality, and cultural implications to solve challenges and strategies in education management and support Sustainable Development Goals (SDGs).	[25]
2	What evidence supports the advancement of language learning through digital innovation? toward achieving sustainable development goals (SDGs) in the 21st century completed with bibliometric analysis	[26]
3	The journal of engineering, science and technology (JESTEC): A bibliometric insight into materials research trends and innovation to support sustainable development goals (SDGs).	[27]
4	Enhancing human evolution literacy through PraksaraVerse: A gamified science learning innovation supporting Sustainable Development Goals (SDGs)	[28]
5	Techno-economic analysis of sawdust-based trash cans and their contribution to Indonesia's green tourism policy and the sustainable development goals (SDGs)	[29]
6	Efforts to improve sustainable development goals (SDGs) through education on diversification of food using infographic: Animal and vegetable protein	[30]
7	Sustainable packaging: Bioplastics as a low-carbon future step for the sustainable development goals (SDGs)	[31]
8	Enhancing innovative thinking through a theory-based instructional model in design education to support Sustainable Development Goals (SDGs)	[32]
9	The influence of environmentally friendly packaging on consumer interest in implementing zero waste in the food industry to meet sustainable development goals (SDGs) needs	[33]

Table 4 (Continue). Previous studies on SDGs.

No	Title	Reference
10	Hazard identification, risk assessment, and determining control (HIRADC) for workplace safety in manufacturing industry: A risk-control framework complete with bibliometric literature review analysis to support sustainable development goals (SDGs)	[34]
11	Enhancing job satisfaction through human resource information systems and communication: A commitment-based approach to achieve Sustainable Development Goals (SDGs) in education-oriented organizations.	[35]
12	Sustainable removal of dyes from wastewater using eggshell-derived calcium carbonate nanoparticles: adsorption isotherms, kinetics, and thermodynamic analysis supporting Sustainable Development Goals (SDGs)	[36]
13	Analysis of student's awareness of sustainable diet in reducing carbon footprint to support sustainable development goals (SDGs) 2030	[37]
14	Effect of substrate and water on cultivation of Sumba seaworm (nyale) and experimental practicum design for improving critical and creative thinking skills of prospective science teacher in biology and supporting sustainable development goals (SDGs)	[38]
15	Smart learning as transformative impact of technology: A paradigm for accomplishing sustainable development goals (SDGs) in education	[39]
16	Implementation of sustainable development goals (SDGs) no. 12: Responsible production and consumption by optimizing lemon commodities and community empowerment to reduce household waste	[40]
17	Development of interpolymer complexes for soil structure and water retention: A scientific and technological contribution to Sustainable Development Goals (SDGs)	[41]
18	Integrating generative artificial intelligence (AI)-based multimodal learning in education to enhance literacy aligned with Sustainable Development Goals (SDGs)	[42]
19	Analysis of the application of mediterranean diet patterns on sustainability to support the achievement of sustainable development goals (SDGs): Zero hunger, good health and well beings, responsible consumption, and production	[43]
20	Developing an inclusive ICT-based academic information system using REST API to promote Sustainable Development Goals (SDGs) in higher education	[44]
21	Current strategies for mitigating airborne pathogen transmission: An integrative review based on aerosol science and particle technology to support the Sustainable Development Goals (SDGs), complemented by a bibliometric analysis	[45]
22	Definition and role of sustainable materials in reaching global Sustainable Development Goals (SDGs) completed with bibliometric analysis	[46]
23	Safe food treatment technology: The key to realizing the sustainable development goals (SDGs) zero hunger and optimal health	[47]
24	Integrated CRITIC-TOPSIS and Monte Carlo sensitivity analysis for optimal various natural fibre selection in sustainable building insulation composites to support the Sustainable Development Goals (SDGs).	[48]
25	Characteristics of jengkol peel (<i>Pithecellobium jiringa</i>) biochar produced at various pyrolysis temperatures for enhanced agricultural waste management and supporting sustainable development goals (SDGs)	[49]

No	Title	Reference
26	Production of wet organic waste ecoenzymes as an alternative solution for environmental conservation supporting sustainable development goals (SDGs): A techno-economic and bibliometric analysis	[50]
27	Contributing factors to greenhouse gas emissions in agriculture for supporting sustainable development goals (SDGs): Insights from a systematic literature review completed by computational bibliometric analysis	[51]
28	Techno-economic analysis of production ecobrick from plastic waste to support sustainable development goals (SDGs)	[52]
29	Influence of self-efficacy on affective learning outcomes in social studies education toward achieving sustainable development goals (SDGs)	[53]
30	Physical adaptation of college students in high-altitude training: Empirical findings and curriculum development insights to support sustainable development goals (SDGs)	[54]
31	Enhancing occupational identity and self-efficacy through a self-education model in art and design education aligned with Sustainable Development Goals (SDGs)	[55]
32	Sustainable development goals (SDGs) in science education: Definition, literature review, and bibliometric analysis	[56]

5. CONCLUSION

The distribution of tourist attractions in Lembang District shows that 17 natural attractions, 17 man-made attractions, and four cultural attractions exhibit a dispersed pattern. This pattern reflects factors such as strategic location, supporting infrastructure, significant market potential, and adequate local government support. In terms of supporting facilities, 32 hotels display a random distribution pattern, while 178 restaurants form a clustered pattern. Each cluster is primarily centered around Lembang Village, with development following the main road corridors that extend across the district. The distribution of restaurants in Lembang Village and hotels along the Lembang-Subang highway demonstrates a relatively regular pattern, closely linked to the spread of natural, man-made, and cultural attractions throughout the area. The synergy among tourism, accommodation, and culinary sectors in this region fosters the growth and expansion of these businesses to meet the needs of visiting tourists.

The location and accessibility of tourist attractions in Lembang District significantly influence the distribution patterns of hotels and restaurants. Natural, man-made, and cultural attractions are irregularly scattered across areas with hilly topography, with many natural sites situated in higher and more remote locations. Forests, valleys, and rivers further separate some attractions physically from one another. With strategic investment in the tourism sector, equitable development of supporting facilities around tourist attractions can be achieved, allowing the full tourism potential of Lembang District to be realized while considering the SDGs. By promoting economic growth, social inclusion, and environmental sustainability, the distribution of tourist attractions, accommodations, and restaurants plays a key role in advancing the SDGs. Tourism contributes to 14 of the 17 SDGs, particularly SDG 8 (enhancing economic opportunities), SDG 1 (reducing poverty), and SDG 5 (promoting gender equality). Achieving these goals requires encouraging responsible tourism practices and raising public awareness to ensure that tourism development aligns with sustainable practices.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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