



Key Message

- Indonesia's services economy is already the main engine, contributing about 43.8 percent of GDP in 2024 and supporting around 71.6 million jobs in 2023, so policymakers need faster and more spatially precise signals than GDP and annual surveys to see where service and tourism growth is actually happening and where pressures are building.
- Nighttime Light satellite data provides that signal because it tracks the intensity and location of activity in real time and it clearly differentiates regional growth patterns, showing Jakarta as a polycentric service and MICE logistics hub that needs mobility and infrastructure upgrades, Bali as a highly concentrated tourism economy that needs diversification and tighter land use management, and Yogyakarta as a cultural and creative quality tourism model that needs connectivity plus heritage and environmental protection.

Nighttime Light (NTL) as a Proxy for Indonesia's Service Sector and Tourism: Building the Nexus of Eventonomics

The service sector has become one of the growth engines for the Indonesian economy. As shown in Table 1, the highlighted sectors represent the Indonesian service industry. When aggregating their contribution, in 2024 alone the service sectors collectively contributed over 43.8% of GDP. Furthermore, the service industry has provided employment for over 71.6 million people in 2023. This underscores the pivotal role of the service industry towards Indonesia's economy.

Table 1. GDP Distribution by Economic Sector (2024)

Sector	GDP Contribution (%)
Agriculture, Forestry, and Fishing	12.61
Mining and Quarrying	9.15
Manufacturing	18.98
Electricity and Gas	1.03
Water Supply, Waste Management, and Recycling	0.06
Construction	10.09
Wholesale and Retail Trade; Vehicle Repair	13.07
Transportation and Storage	6.13
Accommodation and Food Services	2.64
Information and Communication	4.34
Financial and Insurance Activities	4.17
Real Estate Activities	2.35
Business Activities	1.92
Public Administration, Defence, Social Security	3.04
Education	2.81
Health and Social Work	1.26
Other Services	2.05

Source: BPS (2024)

This trend has become a catalyst for what can be termed eventonomics, an economy driven by cultural festivals, international conferences, creative industries, and leisure experiences. Regional dynamics reinforce this transformation: Jakarta has established itself as a hub for finance and MICE (Meetings, Incentives, Conferences, and Exhibitions), Bali has solidified its role as a premier international tourism destination, and Yogyakarta continues to thrive as a center for domestic cultural and educational tourism.

interventions in rapidly evolving economies like Indonesia's. By contrast, Nighttime Light (NTL) satellite imagery, particularly from the Visible Infrared Imaging Radiometer Suite (VIIRS), has emerged as a validated, cost-effective proxy for economic activity that provides both spatial and temporal precision (Zhang & Gibson, 2022).

Additionally, the use of Nighttime Light (NTL) data offers several advantages for policy and planning. NTL

Table 2. Employment Distribution by Sector (2023)

Sector	Employment Share (%)	Approx. Workers (Millions)
Services	49.15	~71.6M
Industry	22.09	~32.2M
Agriculture	28.77	~41.9M
Total	100.0	~145.8M

Source: Statista (2023)

Yet, this momentum brings critical challenges such as overtourism in Bali, congestion in Jakarta, and connectivity gaps in Yogyakarta. Addressing these issues requires data driven planning, integrated infrastructure strategies, and balanced development policies to ensure that Indonesia's growing service sector continues to grow without compromising sustainability.

One of the promising approaches is the adaptation of data driven planning tools such as Nighttime Light (NTL) satellite imagery, which offers a powerful complement to traditional statistics. By integrating NTL analysis to service sector planning, this would help Indonesia in pinpointing emerging service clusters, map tourism drive growth corridors, and identify infrastructure bottlenecks. This data based approach will not only assist in enhancing strategic investments but enable a much more responsible and equitable development in regions experiencing rapid transformation.

The Need to Adapt Fast

Traditional indicators such as GDP and employment statistics are often lagging, coarse, and lack subnational resolution, limiting their usefulness for timely policy

has a high spatial resolution, especially VIIRS imagery, which enables policymakers to detect service-sector clusters and tourism growth corridors with greater precision. (Pagaduan, 2022). NTL also provides temporal sensitivity to economic shocks, which indicates that NTL can detect and reflect changes over time. This was demonstrated by

studies conducted in the United States and China, which captured the impact of COVID-19 lockdowns and infrastructure investments (Lin & Rybnikova, 2023). Furthermore, NTL serves as a proxy for social and infrastructure indicators, given its strong correlation towards electrification, urban density, and service accessibility which makes it a great complementary in mapping income disparities and poverty (Andries et al., 2023).

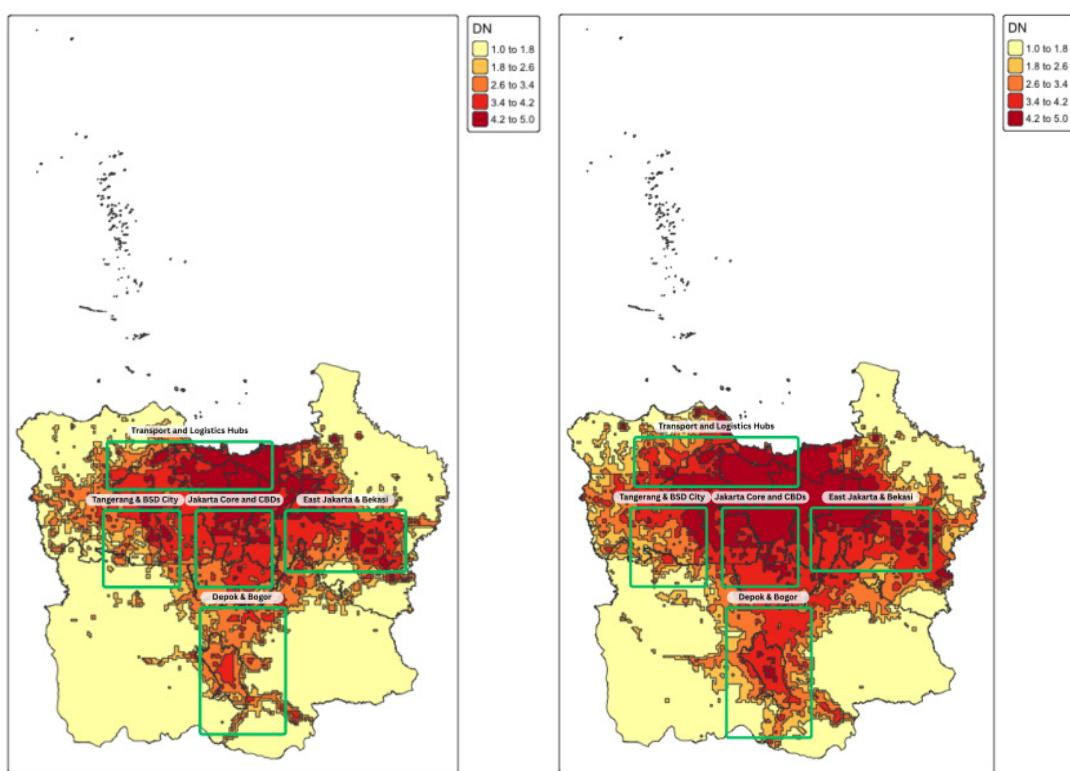
Jakarta Metropolitan Area: Intensifying Service-Sector Growth and Radiance Saturation (2016–2023)

Nighttime Light (NTL) analysis of the Jakarta Metropolitan Area (JMA), which includes Jakarta and its surrounding cities (Bogor, Depok, Tangerang,

Bekasi), between 2016 and 2023 reveals a striking intensification of radiance across the urban core, logistics corridors, port areas, and satellite cities. In 2016, high-radiance clusters (DN > 4.2) were concentrated in Central Jakarta and along select arterial roads. By 2023, these clusters had expanded and merged, forming a nearly continuous belt of brightness stretching from Soekarno-Hatta International Airport in Tangerang to Tanjung Priok Port in North Jakarta, and eastward into Bekasi's industrial-service corridors. This radiance growth illustrates JMA's transformation into a megacity-scale service hub, anchored by finance, ICT, wholesale trade, logistics, and MICE (Meetings, Incentives, Conferences, Exhibitions) industries, which collectively account for a major share of regional GDP.

and Bogor's periphery. The pattern reflects an inverse S-shaped density gradient, where light intensity peaks in Jakarta's historic core but continues outward along major toll roads and rail corridors. McAvoy et al. (2024) highlight that this "distance-decay" lighting pattern is typical of Southeast Asian megacities transitioning to polycentric metropolitan structures, where secondary hubs like BSD City, Bekasi Industrial Corridor, and Cikarang contribute to JMA's economic gravity. The scale of this radiance expansion underscores Jakarta's transformation from a city-centric economy into a networked megacity region, a shift tied to the rapid growth of Indonesia's service economy.

Figure 1. Nighttime lights of Jakarta Metropolitan area



Source : Processed by Author

Notes : 2016 on the left, 2023 on the right

Urban Growth Dynamics

Research shows that the Jakarta Metropolitan Area (JMA) experienced a 19% increase in built-up land between 2000 and 2020, with growth dominated by horizontal sprawl rather than vertical densification (Sarker et al., 2024). This expansion is visible in the NTL maps as a broadening ring of brightness that now extends well beyond central Jakarta into Tangerang, Bekasi, Depok,

Radiance as a Service-Sector Indicator

Jakarta's brightening is directly linked to the rise of its service-oriented economy, which now dominates regional GDP. Financial services, ICT, retail, trade, and logistics hubs are all concentrated in high-radiance clusters such as the Sudirman Central Business District (SCBD), Mega Kuningan, Tanjung Priok Port, and Soekarno-Hatta International Airport.

These hubs act as epicenters for MICE (Meetings, Incentives, Conferences, Exhibitions) activities, which have positioned Jakarta as a global destination for international conventions, business tourism, and investment promotion events. The visibility of these clusters in NTL imagery illustrates the density of nighttime economic activity driven by extended work hours, commercial hubs, and 24-hour logistics operations.

Gibson et al. (2021) demonstrate that VIIRS data provides unmatched clarity in detecting these patterns, overcoming the shortcomings of older DMSP datasets that often blurred intra-urban economic variation. The improved resolution makes it possible to distinguish business districts, airport corridors, and industrial zones from surrounding residential areas. For a metropolitan region that contributes over 20% of Indonesia's GDP, this precision is vital for understanding the spatial distribution of its service economy and for guiding infrastructure investment.

Environmental and Sustainability Implications

The radiance saturation of Jakarta's core is not only a marker of economic intensity but also a signal of environmental strain. High-radiance areas often overlap with urban heat islands (UHI), reduced vegetation cover, and chronic congestion zones. Sarker et al. (2024) highlight that Jakarta's extensive horizontal sprawl has exacerbated flood vulnerability, air pollution, and heat extremes, posing sustainability

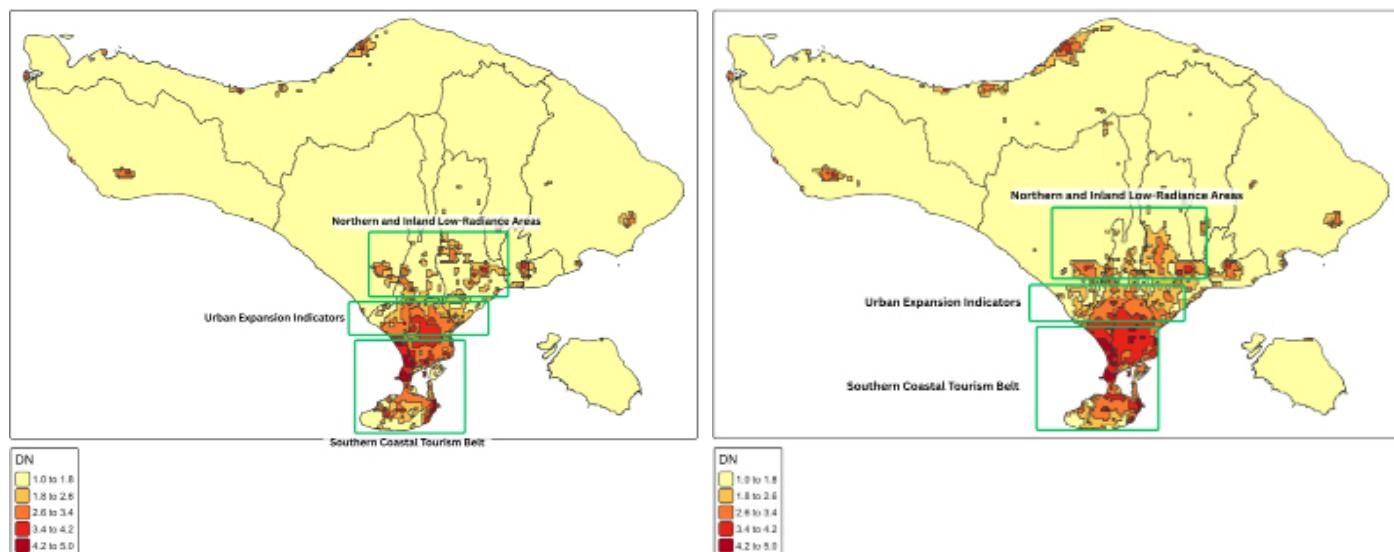
challenges for this megacity region. NTL thus functions as both an economic indicator and a diagnostic tool for ecological imbalance: bright, continuously lit clusters show where economic activity is concentrated, but also where infrastructure stress is most severe.

These patterns have critical implications for the service sector's future growth. Without effective urban planning, the very concentration of service industries and MICE facilities, Jakarta's global comparative advantage, risks being undermined by transport bottlenecks, inadequate public spaces, and environmental degradation. Strategic decentralization to nearby growth nodes like Tangerang and Bekasi, combined with sustainable mobility planning, could help Jakarta preserve its role as a service-sector and convention hub for Southeast Asia.

Bali: Tourism-Driven Radiance Saturation and Coastal Urban Expansion (2016–2023)

Nighttime Light (NTL) analysis of Bali between 2016 and 2023 reveals a pronounced concentration of brightness along the island's southern coastal belt, particularly in Denpasar, Kuta, Nusa Dua, and Sanur, underscoring Bali's identity as Indonesia's premier international tourism hub. In 2016, high-radiance clusters (DN > 4.2) were tightly concentrated in Kuta and Denpasar, while inland areas remained largely dim. By 2023, radiance had intensified and spread outward along major roads

Figure 2. Nighttime lights of Bali area



Source : Processed by Author

Notes : 2016 on the left, 2023 on the right

and coastal corridors, forming continuous illuminated belts linking Ngurah Rai International Airport, Benoa Harbour, and southern beach resorts. This pattern illustrates both the economic centrality of tourism and the geographic concentration of infrastructure investment in southern Bali.

Tourism Intensity and Economic Vulnerability

Bali's NTL signal is highly reflective of its deep reliance on international tourism, making it one of the most sensitive indicators of external shocks in Indonesia's economy. Putro and Pramana (2025) show that NTL radiance dropped by approximately 45% in April 2020 during pandemic lockdowns, closely paralleling the collapse in international tourist arrivals

and a sharp decline in Bali's regional GDP. This dramatic contraction demonstrates NTL's utility as a real-time economic barometer, capable of detecting immediate disruptions in tourism-driven economies. By 2023, NTL levels had rebounded sharply, reflecting renewed international flights, infrastructure reactivation, and the resumption of hotel, retail, and entertainment activity. However, this rebound also highlights Bali's structural dependence on tourism, where over 50% of the economy is directly or indirectly tied to visitor spending, leaving the island highly vulnerable to global market fluctuations, health crises, and travel restrictions.

Land-Use Change and Environmental Implications

Decades of tourism development have transformed Bali's southern region into one of Indonesia's most urbanized coastal landscapes. Andyana et al. (2023) used Random Forest classification of multi-temporal Landsat data (2013–2021) to identify 20.23 km² of vegetated land converted into urban and built-up areas, with hotspots concentrated in Kuta, Denpasar, Jimbaran, and Benoa. These findings align closely with the brightening patterns in the 2023 NTL imagery, demonstrating that satellite light data not only reflects economic activity and service-sector density but also serves as a proxy for land conversion and environmental stress. The dominance of light clusters along the southern coastline underscores the imbalance in spatial development, where northern regencies like Buleleng and Karangasem remain dim, lacking comparable tourism infrastructure. This disparity reflects a long-term trend in which mass tourism has

driven environmental degradation in southern Bali while limiting the economic spillover to rural regions.

Spatial Development Patterns

Bali's NTL patterns reinforce its monocentric tourism geography, heavily concentrated in the southern coastal belt, with few secondary tourism corridors or inland clusters. Unlike Yogyakarta, where tourism is more geographically dispersed, Bali's light saturation is almost entirely focused around Denpasar, Kuta, Legian, Seminyak, Nusa Dua, and Jimbaran, which house the bulk of the island's hotels, resorts, and nightlife infrastructure. The absence of well-lit inland corridors or secondary hubs indicates a polarized tourism economy reliant on a single geographic node. Sutawa (2012) similarly emphasizes that Bali's economic structure is uniquely dependent on mass-tourism clusters, creating a "spatial lock-in" where future growth risks overburdening already congested and environmentally stressed areas. This pattern raises urgent concerns over regional inequality, environmental carrying capacity, and economic resilience, especially as tourism continues to dominate Bali's land-use priorities.

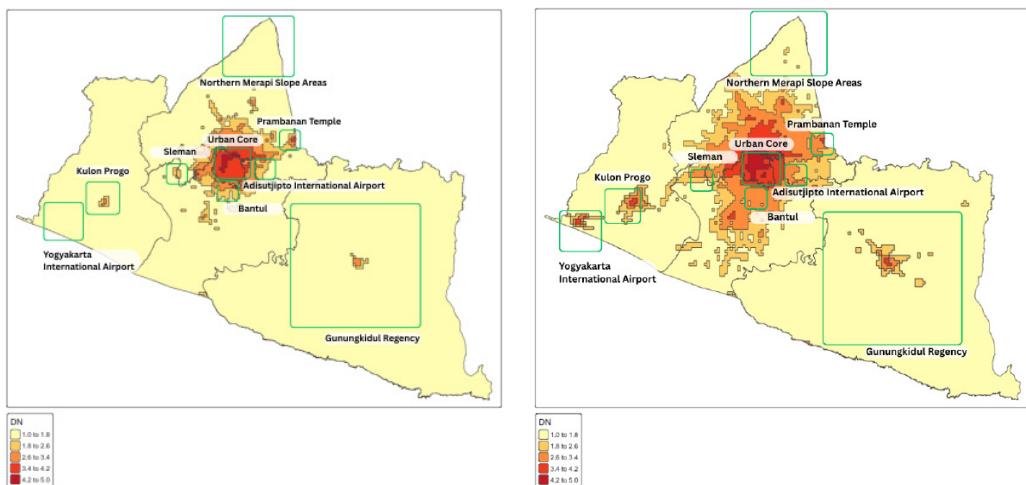
Yogyakarta: Cultural Core, Quality Tourism, and Creative Economy Growth (2016–2023)

Nighttime Light (NTL) data for Yogyakarta Special Region between 2016 and 2023 shows a steady intensification of radiance in Yogyakarta's urban core and Sleman Regency, underscoring the region's role as Indonesia's cultural capital and education-driven growth center. In 2016, high-radiance clusters (DN > 4.2) were concentrated around Malioboro Street and Kraton Palace, but by 2023 these clusters had expanded along Ring Road corridors and peri-urban Sleman, reflecting rising economic activity from tourism, universities, and creative industries (Gunawan et al., 2023).

Urban Growth Dynamics and University-Driven Development

Gunawan et al. (2023) demonstrate that Yogyakarta's dense network of universities, including Universitas Gadjah Mada (UGM), Universitas Negeri Yogyakarta (UNY), and Universitas Islam Indonesia (UII), is a major

Figure 3. Nighttime lights of Special Region of Yogyakarta area



Source : Processed by Author

Notes : 2016 on the left, 2023 on the right

driver of peri-urban growth in Sleman and Bantul. These institutions attract tens of thousands of students from across Indonesia each year, stimulating housing demand, retail expansion, and service-sector activity. The NTL maps confirm this pattern, showing medium- to high-radiance corridors radiating outward from the historic city center into suburban zones along arterial roads. Rather than centralized vertical growth, Yogyakarta's development is characterized by horizontal spread anchored to educational nodes, creating a polycentric urban form. This university-driven expansion also supports the city's thriving creative and cultural industries, positioning Yogyakarta as a knowledge-based growth hub distinct from Bali's tourism monoculture or Jakarta's financial agglomeration.

Tourism Patterns and the Rise of Quality Tourism

Yogyakarta has positioned itself as a national leader in quality, sustainable tourism, prioritizing cultural authenticity, heritage preservation, and ecotourism. The city serves as a gateway to globally recognized attractions, including Borobudur and Prambanan Temples, Mount Merapi National Park, and Gunungkidul's extensive cave and beach ecotourism sites. These attractions cater to domestic and international tourists seeking experiential and nature-focused travel, rather than mass coastal tourism. NTL imagery illustrates this model: while Yogyakarta's city center glows brightly, many of its surrounding regencies remain dim, demonstrating deliberate preservation

of rural landscapes and ecological corridors (Riza et al., 2025). The emergence of small, isolated light clusters in Gunungkidul and Kulon Progo corresponds to growing eco-resorts, adventure tourism, and local homestays. This spatial signature contrasts sharply with Bali's continuous coastal radiance belt, reinforcing Yogyakarta's niche as a sustainable and diversified tourism hub.

Creative Economy as a Growth Driver

Yogyakarta's designation as a UNESCO Creative City of Crafts and Folk Art underscores its role as a national epicenter of creative industries. The city has become a magnet for artists, designers, and digital entrepreneurs, building on its centuries-old cultural heritage. Clusters of batik workshops, silver craft villages (Kotagede), and ceramics hubs (Kasongan) have evolved into thriving creative districts, supported by local universities and international collaborations. Modern sectors such as digital design, animation, and co-working spaces have flourished, turning Sleman and Bantul into creative economy growth poles. This growth is mirrored in the NTL imagery, where moderate-radiance zones in peri-urban areas reveal rising entrepreneurial activity beyond the historic city core (Gunawan et al., 2023; UNESCO, 2014). Yogyakarta's creative ecosystem not only bolsters tourism but also diversifies the regional economy, reducing over-reliance on a single sector and creating a resilient, innovation-driven development model.

Comparative Summary of Regional NTL Findings and Policy Implications

The analysis of Nighttime Light (NTL) data across the Jakarta Metropolitan Area, Bali, and Yogyakarta highlights the value of satellite-based radiance as a spatial-economic indicator for tourism planning, service-sector monitoring, and sustainable development. While Jakarta's radiance patterns reveal a dense, polycentric megacity economy anchored in finance, logistics, and MICE industries, Bali's imagery captures the risks of monocentric tourism

concentration and environmental degradation, and Yogyakarta showcases a balanced growth strategy emphasizing cultural authenticity, nature-based tourism, and creative economy innovation.

To consolidate these insights, the following tables summarize each region's primary growth drivers, NTL evidence, and strategic policy recommendations. Together, they demonstrate how NTL data can move beyond academic research into practical, decision-making tools for Indonesia's urban and tourism policymakers.

Table 3. Jakarta Metropolitan Area: Service-Sector and Megacity Dynamics

Driver	NTL Evidence	Policy Implications
Service-Sector Dominance	Continuous high-radiance clusters in SCBD, Mega Kuningan, Tanjung Priok, and Soekarno-Hatta Airport show Jakarta's role as a service and MICE hub (finance, ICT, logistics).	Invest in transport nodes, digital infrastructure, and MICE facilities to strengthen Jakarta's global competitiveness.
Urban Sprawl	Built-up land expanded 19% (2000–2020); NTL brightness extends into Tangerang, Bekasi, and Depok, showing polycentric growth.	Promote polycentric urban planning; support secondary hubs to relieve Jakarta's core congestion.
Environmental Stress	Radiance saturation overlaps with UHI, flood-prone zones, and air pollution corridors.	Implement green infrastructure and sustainable mobility systems to reduce environmental strain.

Source : Processed by Author

Table 4. Bali: Tourism Concentration and Environmental Challenges

Driver	NTL Evidence	Policy Implications
Tourism Dependence	Sharp 45% drop in NTL radiance during April 2020 lockdowns, followed by rapid rebound.	Diversify Bali's economy; build resilience frameworks for external shocks.
Land-Use Conversion	20.23 km ² vegetation loss (2013–2021); bright coastal belts in Kuta, Nusa Dua, and Denpasar.	Strengthen zoning enforcement, protect northern and inland areas from unchecked sprawl.
Monocentric Development	Lack of inland radiance clusters shows tourism monocentrism in the south.	Develop secondary destinations in Buleleng, Karangasem, and north Bali to reduce over-concentration.

Source : Processed by Author

Table 5. Yogyakarta: Quality Tourism and Creative Economy Growth

Driver	NTL Evidence	Policy Implications
University-Driven Growth	Radiance corridors from city center into Sleman and Bantul linked to campus clusters (Gunawan et al., 2023).	Support polycentric nodes around universities; manage housing and transit demand.
Quality & Nature Tourism	Small, dispersed NTL clusters in Gunungkidul and Kulon Progo; rural areas remain dim and preserved (Riza et al., 2025).	Prioritize ecotourism infrastructure; maintain environmental integrity of rural tourism corridors.
Creative Economy	Moderate radiance in Sleman/Bantul reflects creative clusters (batik, crafts, co-working hubs) (Gunawan et al., 2023; UNESCO, 2014).	Link creative industries with tourism branding; support creative hubs through policy incentives.

Source : Processed by Author

NTL Insights Keytakeaways

The comparative analysis of the Jakarta Metropolitan Area, Bali, and Yogyakarta demonstrates the transformative potential of Nighttime Light (NTL) imagery as a decision-support tool for policymakers. NTL data serves as a high-frequency, spatially detailed proxy for economic activity, tourism intensity, and infrastructure development, offering insights that complement conventional statistics, which often lag in accuracy and resolution. By examining radiance patterns over time, this study highlights how Indonesia's service sector and tourism economy are evolving into a cohesive platform for Eventonomics, an emerging economic model in which cultural festivals, international conventions, creative showcases, and tourism experiences function as growth multipliers for local and regional economies.

Jakarta's dense service-sector clusters, financial districts, and world-class MICE (Meetings, Incentives, Conferences, Exhibitions) facilities solidify its status as Southeast Asia's leading business hub, where infrastructure development and global connectivity converge. Bali, long celebrated for its hospitality and leisure industries, illustrates both the opportunities and vulnerabilities of a tourism-centric economy: its radiance saturation captures a concentration of wealth,

culture, and infrastructure in the south but also warns of environmental pressures and monocentric growth risks. Yogyakarta, by contrast, presents a balanced model of cultural authenticity, heritage preservation, and quality tourism, complemented by thriving creative industries and university-driven urbanization. Together, these three regions provide a microcosm of Indonesia's development pathways, from global event hosting to grassroots creative entrepreneurship.

Integrating NTL data into policymaking offers Indonesia a real-time, evidence-based planning tool for identifying emerging tourism corridors, managing infrastructure bottlenecks, and protecting ecologically sensitive areas. Through this lens, Eventonomics becomes more than a branding strategy: it is a strategic framework for economic diversification, cultural diplomacy, and sustainable growth. By leveraging its rich cultural heritage, world-renowned hospitality sector, and growing creative economy, Indonesia can position itself as a regional leader in sustainable event-driven development, attracting investment while preserving environmental and cultural integrity.

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