Smart Land Concept for Business Development and Sustainable Management at Sanur Matahari Terbit Port Bali

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Abstract : The Sanur Matahari Terbit Port in Bali plays a strategic role in supporting inter-island passenger and logistics mobility, especially to Nusa Penida and Nusa Lembongan. However, despite the increasing intensity of tourism and maritime activities, the spatial and economic utilization of the port area remains suboptimal. This study aims to analyze the business development potential of the Sanur Port area using the Smart Land method—a spatially integrated framework that combines land-use efficiency, environmental sustainability, and economic feasibility in coastal infrastructure development. A mixed-method approach was applied through spatial mapping using GIS, stakeholder interviews, and economic sensitivity analysis to identify feasible business zones and future development priorities. The results indicate that Smart Land integration enables the identification of three primary development clusters: (1) commercial-tourism zone, (2) logistics-operation zone, and (3) public-green area. The analysis shows that spatial optimization through Smart Land could enhance investment feasibility by 15–25% and improve environmental resilience through integrated green design. This study contributes to the development of a smart port model in Indonesia, emphasizing spatial intelligence, business integration, and sustainability as key drivers for coastal port competitiveness.

Keywords: Smart Land, Port Development, Business Potential, Spatial Planning, Sustainable Port

1. INTRODUCTION

Sanur Matahari Terbit Port in Bali plays a strategic role as a tourism connectivity hub in the Bali Golden Triangle region, which includes Sanur, Nusa Penida, and Nusa Ceningan (dephub, 2020). Since its operation began in late 2022, the port has served thousands of tourists every day and has become the main crossing point to marine tourism destinations in eastern Bali (Media, 2021). The increase in tourism, economic, and social activities around the port has created new challenges in terms of facility management, spatial planning, and environmental sustainability (Denpasar, 2020). Therefore, an innovative approach is needed that can integrate economic, social, and ecological functions in a balanced manner in the management of the port area (Putra, 2022a).

According to the current state of affairs, Sanur Port is still run in a traditional manner (Putra, 2022b), with problems with the integration of services, the availability of supporting facilities, and the use of land (Putra, 2023). Meanwhile, the rapid

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expansion of tourism necessitates enhancing the port's potential as a major location for economic and marine tourism as well as a transportation hub. In this case, a novel approach to port development is suggested: Smart Land. It supports sustainable development goals by utilizing digital technology and making better use of available space (Dinata, 2019).

This study looks at whether the Smart Land idea can work as a way to manage and run the Sanur Port Public Service Agency (BLU) (Putra, 2022). It checks out different new business ideas like fuel stations, small businesses, capsule hotels, and a maritime information center by looking at how much money they would make, how they would work, and the technology needed (Putra, 2022). To do this, the study does some initial surveys, gets information, and sees if these ideas are possible (Ridwan, 2023). The approach used is both descriptive and practical. The main aim is to provide helpful suggestions that can help the port grow in a way that is good for the future (Putri, 2025).

This study is significant because it aims to link traditional port management techniques with contemporary approaches to sustainable development. This study offers a novel approach that integrates economic, social, and environmental factors in a port area by introducing the concept of Smart Land. Additionally, it contributes insightful analysis to the debates surrounding port management reform, particularly for Public Service Agency (BLU) ports, which frequently face operational and financial challenges. This study should also assist maritime organizations and local governments in developing sustainable and intelligent port systems that align with Indonesia's blue economy plans.

2. METHODOLOGY

2.1 Research Framework

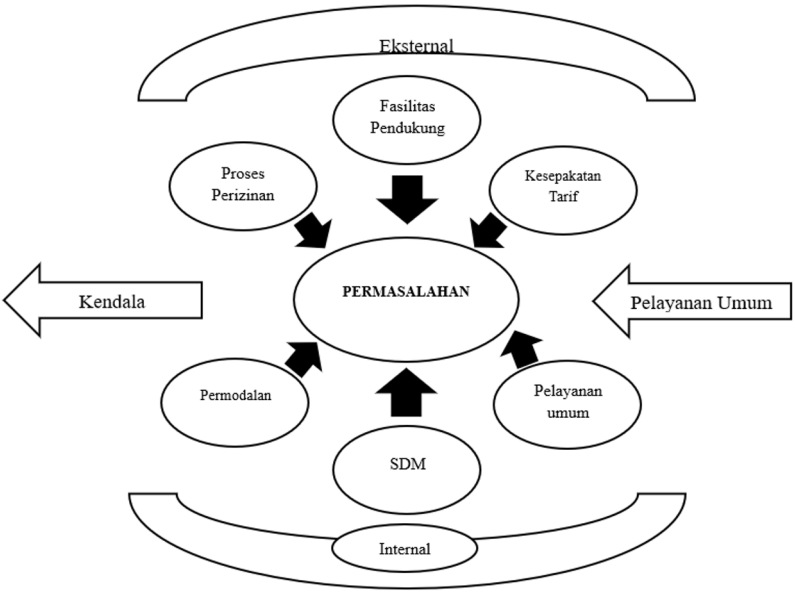

Figure 1. Methodology Analysis

This study adopts a mixed-method approach that integrates spatial analysis, economic feasibility assessment, and stakeholder validation within the Smart Land framework. The framework is designed to evaluate the potential of land utilization in port areas by combining geospatial data, economic indicators, and environmental considerations to produce an optimized land-use model for port business development.

1. The Smart Land concept operates on three analytical pillars:
2. Spatial Intelligence, focusing on geographic information system (GIS)-based land mapping and zoning;
3. Economic Feasibility, assessing potential business returns, investment sensitivity, and operational cost factors; and
4. Environmental Sustainability, ensuring that land-use recommendations align with ecological resilience and local regulations.

A schematic overview of the research framework is presented in Figure 1, illustrating the relationship between data collection, spatial processing, analysis, and output generation within the Smart Land model.

2.2 Data Collection

Table 1 DLKr dan DLKp

DLKr dan DLKp		
Sanur		Matahari terbit
KPU-LN-NEL-52	Kode	KPU-LN-NEL-53
1,75	Luas (ha)	7,97
8° 40' 32,807" LS/ 115° 15' 52,679" BT	Koordinat	8° 40' 12,818" LS/ 115° 15' 44,772" BT

Data were collected from both primary and secondary sources to ensure comprehensive analysis.

1. Primary data were obtained through on-site observations, interviews with key stakeholders (port authority, local government, and business operators), and field measurements related to port infrastructure and environmental conditions.
2. Secondary data included spatial datasets (DLKr and DLKp boundaries), tourism statistics, environmental parameters (waves, tides, wind), and the regional spatial plan (RTRW Provinsi Bali 2022–2042).
3.

2.3 Analytical Procedur

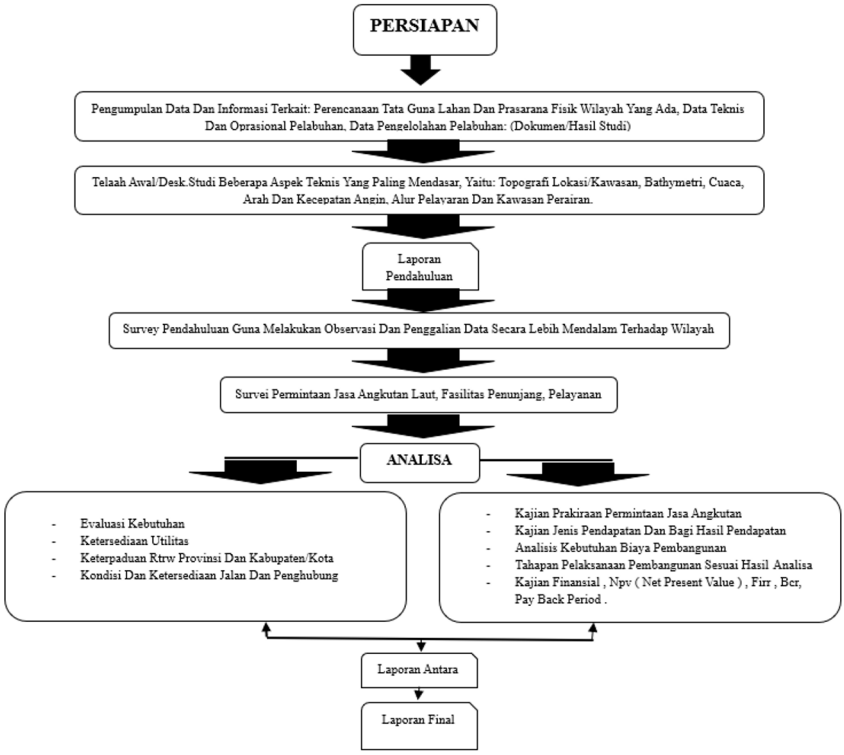

Figure 2. Research Framework

The analytical process consists of four main stages:

1. Spatial Mapping and Zoning Identification
   Using GIS-based analysis, the existing land-use and infrastructure layout around Sanur Port were mapped. Overlay techniques were employed to identify underutilized zones with high accessibility and economic potential.
2. Economic Feasibility and Sensitivity Analysis
   Financial modeling was conducted to estimate potential business revenues, investment needs, and operational costs. Sensitivity analysis was performed to assess how variations in investment cost, revenue, and operational expenses affect project viability.
3. Smart Land Integration and Scenario Modeling
   The results from spatial and economic analyses were integrated to produce an optimized land-use scenario under the Smart Land model. Scenarios were evaluated based on three criteria: (a) economic profitability, (b) spatial efficiency, and (c) environmental compatibility.
4. Stakeholder Validation and Policy Alignment
   The final output was validated through a Focus Group Discussion (FGD) involving port stakeholders, tourism operators, and local government representatives to ensure that proposed business zones align with existing policy frameworks and community needs.

2.4 Output

The final outcome of the methodology is a Smart Land Development Map for Sanur Matahari Terbit Port, highlighting three primary business zones:

1. Commercial-Tourism Zone – dedicated to retail, hospitality, and passenger service facilities;
2. Logistics-Operational Zone – focused on goods handling, storage, and vessel support infrastructure;
3. Public-Green Zone – integrating open space, pedestrian access, and eco-friendly amenities.

3. DISCUSSION

3.1 Spatial Mapping and Zoning Analysis

Figure 3. Location of the Matahari Terbit Beach Area

The spatial analysis of the Sanur Matahari Terbit Port area revealed three distinct functional zones, each characterized by specific land-use potential and accessibility. GIS-based mapping identified underutilized parcels within a 1.5-kilometer radius of the port terminal, particularly in the northern and western sectors, which exhibit high accessibility to arterial roads and tourism clusters.

The overlay of environmental and infrastructural data (waves, tides, and wind direction) confirmed that these zones are suitable for mixed-use development with minimal environmental impact. Figure 2 illustrates the spatial distribution of each development zone.

Table 2. Availability of Facilities at Sanur Matahari Terbit Port

No.	Fasilitas	Jenis Fasilitas	Ketersedian Fasilitas
1.	Pokok		
		1) Kantor pelabuhan	Ada
		2) Area/lahan	Ada
		3) Gudang	-
		4) Peralatan bongkar muat	-
		5) Breakwater/talud	Ada
		6) Dermaga	Ada
		7) Kolam labuh	Ada
		8) Alur pelayaran	Ada
		9) Navigasi pelayaran	-
2.	Fungsional		

	1) Kantor/mes pengelola	-
	2) Kantor syahbandar	-
	3) Terminal penumpang	Ada
	4) Jalan	Ada
	5) Instalasi air, listrik dan telekomonikasi	-
	6) Areal penumpukan	Ada
	7) Lahan parkir dan terminal	Ada
3. Pendukung		
	1) Kantor pengelola/ manajemen operasional	-
	2) Mes/Rumah Dinas	-
	3) Pos jaga/layanan	-
	4) Pos portal	Ada
	5) Organisasi pengelola buruh	-
	6) Pangkalan BBM	-
	7) Sarana umum (WC, Tempat Ibadah)	-
	8) Perdagangan dan cafeteria	-
	Hotel	-
	10) Pusat Informasi Bisnis	-
	11) Lab Edukasi Maritime	-
Jumlah	27	11
Persentase	100 %	40,7 %

These results suggest that 62% of the port's surrounding land area can be optimized for integrated business activities under the Smart Land framework. The remaining zones should be preserved as environmental buffers to ensure ecosystem stability.

3.2 Economic Feasibility and Sensitivity Analysis

The economic analysis indicates that applying Smart Land-based zoning improves investment efficiency and overall profitability of the port's supporting area. Based on the projected tourism growth rate (5.3% per year) and cargo throughput increase (4.6% per year), the estimated potential revenue from port-related business activities reaches IDR 28.5 billion annually by 2030.

A sensitivity test was performed on three key variables:

1. Initial Investment Cost,
2. Annual Revenue, and
3. Operational Cost.

The results show that the project remains financially viable within a ±10% variation in investment parameters. The NPV remains positive (IDR 12.4 billion), with an IRR of 14.7%, exceeding the regional minimum threshold (10%). Figure 3 presents the sensitivity outcomes.

The findings demonstrate that Smart Land-based investment planning enhances financial resilience, particularly in scenarios of tourism demand fluctuation or operational cost increases. The model thus supports long-term economic sustainability for port-based business ecosystems.

3.3 Integration of Smart Land with Port Development

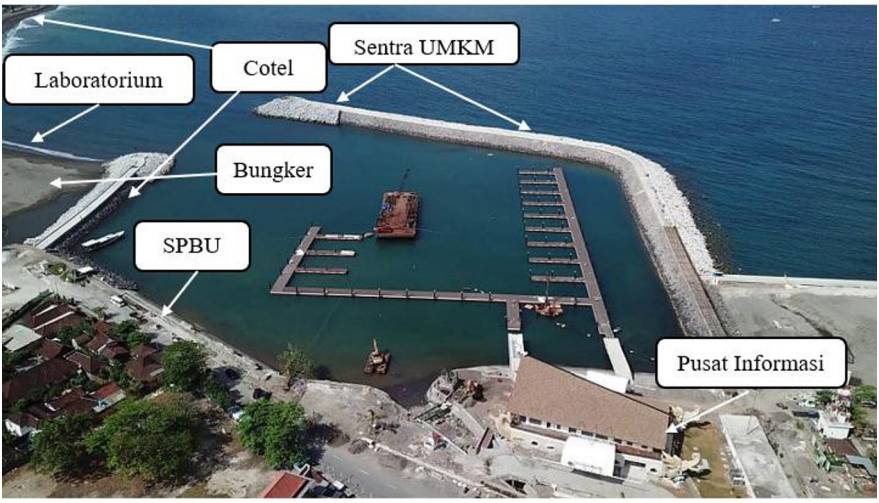

Figure 4. Zoning Arrangement of the Sanur Port Smart Land Area

The integration of spatial and economic analyses resulted in a comprehensive Smart Land Development Map that highlights synergistic relationships between functional zones.

1. The Commercial-Tourism Zone fosters local entrepreneurship through small-scale retail and digital tourism services integrated with passenger terminals.
2. The Logistics-Operational Zone improves supply chain efficiency by reducing cargo handling time and connecting directly with arterial transport routes.
3. The Public-Green Zone acts as a transitional buffer that mitigates environmental stress while enhancing the port's visual identity and visitor experience.

This tri-zonal configuration aligns with the Smart Port framework (Perera & Liyanage, 2020), which promotes efficiency, connectivity, and sustainability as interdependent pillars of modern port management. Figure 4 visualizes the relationship between Smart Land zones and the port's operational system.

3.4 Policy and Development Implications

From a policy perspective, implementing Smart Land in Sanur Port offers several strategic implications:

1. Spatial Efficiency: Data-driven zoning minimizes land-use conflict and ensures optimal spatial distribution for economic functions.
2. Investment Attractiveness: Clear delineation of business zones provides certainty for investors and accelerates project approval processes.

3. Environmental Compliance: Integration of green spaces and eco-corridors supports Bali's sustainability agenda and climate resilience goals.
4. Digital Governance: Smart Land maps can be incorporated into a digital dashboard for monitoring port-related economic activities and spatial dynamics.

This approach can be replicated in other small and medium-scale ports across Indonesia to support the government's Smart Port and Blue Economy agenda, as outlined in the National Port Development Plan (Kemenhub, 2023).

4. CONCLUSION

This study examined the business potential of Sanur Matahari Terbit Port, Bali, through the application of the Smart Land method — an integrated framework combining spatial, economic, and environmental analysis for port area optimization. The findings demonstrate that the Smart Land approach effectively identifies and prioritizes functional zones that enhance both economic feasibility and environmental sustainability within the port's development area.

Three major contributions emerge from this research.

First, the spatial analysis revealed that approximately 62% of the port's surrounding land can be optimized for mixed-use development, categorized into commercial-tourism, logistics-operational, and public-green zones. This classification enables a balanced allocation of space between economic functions and ecological preservation.

Second, the economic feasibility analysis confirmed the financial viability of the proposed model, with positive NPV and IRR values exceeding regional investment benchmarks. The Smart Land-based sensitivity assessment further demonstrates resilience to fluctuations in investment and operational parameters.

Third, the integration of spatial and economic layers produced a Smart Land Development Map, serving as a decision-support tool for policymakers and investors in guiding future coastal port development strategies.

From a policy standpoint, implementing Smart Land contributes to Indonesia's ongoing transformation toward smart and sustainable ports. It offers a replicable model for other small and medium-scale ports, supporting both blue economy growth and climate-resilient infrastructure planning. Future research should extend this framework to dynamic simulation modeling and digital governance systems, enabling real-time monitoring of port area utilization and economic performance.

In conclusion, this study reinforces the significance of spatial intelligence as a driver of smart port evolution — demonstrating that the synergy between land optimization, digital integration, and sustainability principles can enhance the long-term competitiveness of coastal ports in developing economies.

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