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Logistic Aerocity: Optimizing financial feasibility through public-private partnerships

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ABSTRACT

Logistics infrastructure is crucial in urban freight transport and regional economic growth. Airport-centric development has emerged as a potential solution for urban logistics by enabling faster freight movement and broader geographic coverage while integrating business, commercial, and industrial zones. However, this approach faces significant challenges, particularly in emerging economies like Indonesia, where limited public funding creates a substantial infrastructure financing gap. This study proposes a conceptual design for airport-centric logistics infrastructure to address this issue, using Radin Inten II International Airport in Lampung Province, Indonesia, as a case study. The research adopts a mixed exploratory-descriptive approach that integrates land use planning, transportation networks, and zoning regulations with financial engineering analysis through Life Cycle Cost (LCC) to evaluate spatial and financial feasibility. This study develops the Logistic Aerocity concept, which consists of five key zones: Airport Development, Integrated Logistics Hub, Industrial Park, Commercial Area, and Urban Open Space. The financial analysis confirms that a Public-Private Partnership (PPP) financing scheme enhances investment viability and attracts private-sector participation. The projected Internal Rate of Return (IRR) of 15.86% demonstrates the effectiveness of cost-sharing mechanisms between the public and private sectors in ensuring long-term financial sustainability. These insights provide a strategic foundation for policymakers and investors to enhance logistics infrastructure and strengthen urban connectivity through airport-centric development.

1. Introduction

Population growth and urban development have significantly increased the demand for urban freight transport, putting considerable pressure on urban space create logistical challenges such as traffic density (Browne et al., 2012; He and Haasis, 2019). These issues are compounded by inadequate logistics infrastructure, which negatively impacts urban economic development, social well-being, and environmental sustainability (Quak, 2008). To address these challenges, logistics infrastructure is required to enhance urban freight transport's speed, efficiency, and effectiveness (Gleissner and Femerling, 2013).

Airports are critical in facilitating freight logistics because they provide faster travel times and broader geographic coverage than other transport modes (Boloukian, 2018). Globally, airports have evolved beyond transport hubs to become catalysts for economic activity, encouraging the development of airport cities that integrate business,

commercial, and industrial zones (Kasarda, 2008). These cities facilitate global trade, innovation, and regional connectivity by attracting industries and businesses to their surrounding areas by developing aerotropolis (Banai, 2017). The concept of an aerotropolis is often complemented by the establishment of logistics hubs, which play a critical role in supporting the efficient transportation of goods and promoting the development of surrounding industrial zones (Boloukian and Siegmann, 2016; Setyawati et al., 2023). While these successes demonstrate the transformative potential of airport cities, Indonesia faces unique barriers, including inadequate logistics infrastructure and limited funding for large-scale projects.

Infrastructure development in the country requires substantial investment, with the Indonesian National Planning Agency estimating that only 37 % of the budget needed for infrastructure can be financed by the government (Bappenas, 2020). To address this financing gap, alternative financing mechanisms, such as Public-Private Partnerships (PPPs), have

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emerged as promising solutions, pooling private investments, sharing risks, and enhancing efficiency in airport infrastructure development (Carnis and Yuliawati, 2013). Global evidence from successful PPP implementations highlights their potential to efficiently develop airport-centric logistics infrastructure in Indonesia, leveraging private investments to address critical funding and development challenges (Gupta, 2015; Sambrani, 2014). A comprehensive financial feasibility study is needed to determine the feasibility of PPP schemes and optimize their implementation for logistics infrastructure.

Various studies provide further insights into PPP applications in infrastructure development. For example, Goh et al. (2025) examine the integration of photovoltaic facilities with agricultural land in US South Dakota using PPPs and reveal how they balance infrastructure development with environmental benefits. Similarly, Jayasena et al. (2024) investigate PPP adoption in smart infrastructure projects in developing nations and identify political, financial, and technical enablers as critical factors. Furthermore, Endo et al. (2024) examined governance structures and financial arrangements in urban railway projects in Manila, the Philippines. Additionally, Mundonde and Makoni (2024) propose a framework for financing water and sanitation PPP infrastructure in Zimbabwe and emphasize the importance of stakeholder engagement and financial markets. These studies exhibit the adaptability of PPPs to various sectors and their potential to increase private-sector participation.

Despite extensive research on PPPs in various infrastructure sectors, research remains scarce on their application to logistics infrastructure in emerging countries, particularly Indonesia. This gap underlines the necessity for targeted research to address the region's unique logistics infrastructure challenges. This study seeks to fill the gap by proposing an airport-centric logistic hub at Radin Inten II International Airport in Lampung province, Indonesia, which is set to become an airport city with significant capacity for future development. Previous studies have developed the aerotropolis design for Radin Inten; however, they have not yet comprehensively integrated the logistics infrastructure (Berawi et al., 2017). Therefore, a conceptual design of Logistic Aerocity, an airport-centric logistic hub, is proposed, and the optimal PPP scheme for financing is estimated.

This research employs a mixed exploratory-descriptive approach that integrates benchmarking study, land use analysis, spatial modeling, expert interviews, and financial engineering simulations using Life Cycle Cost (LCC) analysis. The findings provide strategies to optimize investment feasibility through cost-sharing mechanisms and sustainable urban development frameworks for policymakers and investors. By addressing logistics infrastructure challenges and bridging the infrastructure funding gap, this study contributes to the body of knowledge on PPP applications for airport-centric development.

2. Literature study

Airport cities are hubs that integrate airports with surrounding business, industrial, and logistics zones. These developments create ecosystems that extend beyond the airport's traditional role as a transport node. Their structure consists of multiple functional elements that support connectivity and enable the efficient movement of people and goods (Fernández et al., 2022). Multimodal networks link airports to nearby clusters, which contributes to trade expansion, innovation, and regional economic growth.

Logistic hubs within airport cities have evolved from traditional warehousing, storage, and shipping service roles to the more complex value-added services of consolidation, maintenance, customs, final assembly, and repairs (Europlatforms, 2004; Rimienė and Grundey, 2007). These facilities support supply chain operations by increasing freight efficiency and reducing logistical fragmentation (Drljača et al., 2020; Lima et al., 2010).

Furthermore, they provide a range of economic, operational, and environmental benefits. Wu et al. (2020) state that they increase trade

opportunities by facilitating global market access and creating cargo handling, transportation, and warehousing jobs. Mokhele and Mokhele (2022) report that key sectors, including pharmaceuticals and manufacturing, tend to cluster around these hubs. Operationally, Li et al. (2024) describe how technologies implemented in these hubs, such as Automated Guided Vehicles (AGVs) and Artificial Intelligence (AI), can improve cargo handling speed and precision. Shi and Hu (2024) highlight that multimodal connectivity minimizes supply chain disruptions and optimizes logistics performance. Environmentally, Gu et al. (2023) note that shorter ground transport routes can significantly reduce carbon emissions.

Recent research presents various perspectives on airport-centric development and PPP-based financing. Fernandez et al. (2023) demonstrate that converting underutilized airport at Josep Tarradellas Barcelona-El Prat Airport into an Airport City supports job creation and economic growth. Kim and Carswell (2024) find that PPP-based airport projects in Atlanta improve land values and stimulate regional investment. In addition, Benmansour (2016) highlights that PPPs for financing and managing airport infrastructure in Tunisia can improve service delivery and infrastructure quality by allowing the private sector to finance and operate airport components over a long-term period before transferring ownership back to the government.

This study builds on existing research concerning airport city development and PPP-based infrastructure financing. Previous studies have shown that integrating logistics hubs within airport-centric developments can strengthen regional connectivity, support economic growth, and reduce environmental impacts. Researchers such as Cruz and Marques Cruz and Marques (2011) and Carnis and Yuliawati (2013) have emphasized the need for structured governance, balanced risk distribution, and regulatory alignment in PPP frameworks.

Overall, the literature highlights how airports have evolved into complex economic centers, with airport cities and logistics hubs are seen as drivers of trade, innovation, and regional development. Prior studies emphasize the economic, operational, and environmental benefits of airport-centric development and recognize logistics as a key enabler of these outcomes. PPPs have been explored as a practical solution for financing large-scale infrastructure, especially in settings with limited public budgets. These studies stress the importance of clear governance structures and balanced risk allocation between sectors. Building upon this existing body of knowledge, this paper contributes to the field by introducing the Logistic Aerocity model, which addresses the planning and financing of a logistics-centered airport development in an emerging economy. Unlike earlier work, it proposes an integrated spatial concept that combines core airport functions with logistics, industrial, commercial, and urban elements. It also includes a financial feasibility analysis using LCC and evaluates a range of PPP cost-sharing structures. This integrated design-financing approach responds to a gap in the literature, where examples that connect spatial planning with investment modeling remain limited.

3. Research framework

This exploratory-descriptive study aims to develop a Logistic Aerocity model at Radin Inten II International Airport in Lampung Province, Indonesia, and evaluate its financial feasibility. The study focuses on achieving two key research objectives (ROs): (1) developing a conceptual design of airport-centered logistics infrastructure through the Logistic Aerocity concept, which integrates aeronautical and non-aeronautical services, and (2) evaluating its financial feasibility using a PPP financing scheme.

This study adopts a mixed-methods approach that combines qualitative and quantitative methods to achieve these objectives. For RO1, qualitative methods include a literature study, benchmarking, spatial modeling, and in-depth expert interviews. The literature study establishes the theoretical basis for airport city concepts and PPP schemes while benchmarking investigates successful implementations in similar

contexts. Spatial modeling defines the land use and spatial arrangements for the Logistic Aerocity to align with regional development goals. Expert interviews validate the conceptual design and obtain practical recommendations. For RO2, the quantitative method is employed, with financial simulations conducted using LCC analysis to assess investment feasibility and identify optimal cost-sharing scenarios.

LCC analysis was selected due to its ability to evaluate the total cost of ownership across the project lifecycle and determine the most cost-effective and sustainable investment strategies (Lemer, 2015). It supports early decisions by aligning initial costs (IC) with operational and maintenance (O&M) expenses to maximize value for money and optimize public-sector investments (Heralová, 2017; Manatkar, 2018). Additionally, LCC considers energy-efficient options that enhance the project's economic and environmental performances (Kale et al., 2016).

The research process is organized into three sequential steps (see Fig. 1). Step 1 focuses on problem identification and theoretical foundation through a literature study of airport city models, airport-centric logistic hubs, and PPP schemes. Step 2 develops the Logistic Aerocity design through benchmarking, land use analysis, spatial modeling, and expert validation. Step 3 evaluates the financial feasibility of the validated design using LCC analysis. Steps 1 and 2 address RO1, while Step 3 addresses RO2. The detailed method for each step is presented in the following subsections.

3.1. Literature study determining Logistic Aerocity's conceptual design variables

The Logistic Aerocity model proposed in this study expands on the aerotropolis concept developed by Berawi et al. (2017), which positions airports as central hubs for regional development by integrating logistics, commercial, and industrial functions. The integrated development around Radin Inten II International Airport requires an area of approximately 1,446.9 ha, with four major components: (1) the airport, covering around 770 ha; (2) an industrial zone of approximately 430.6 ha; (3) a mixed-use area of 101.6 ha; and (4) 144.7 ha of supporting infrastructure (see Fig. 2).

Logistic Aerocity was then added to the aerotropolis after considering the regional potential in Lampung province. It serves as a broader aerotropolis's multimodal logistics and commercial center by integrating core airport business, dependent, and related industries to establish the airport as a central logistics hub (Kasarda, 2008). Fig. 3 illustrates the relationship between this study's Logistic Aerocity and the Radin Inten Aerotropolis.

The literature study identifies best practices in three key topics: airport cities, airport logistics hubs, and airport development PPPs. Articles were selected based on relevance, while government policies and regulations contextualized the analysis. A meta-analysis was conducted to systematically extract and compare key variables that influence the design and financing of airport-centric infrastructure. This approach provided a structured foundation for identifying essential design parameters and aligning them with financial modeling needs. This analysis was critical for formulating the conceptual framework that guided the development of the Radin Inten Logistic Aerocity.

Twenty peer-reviewed papers were purposively selected to support the conceptual foundation of this study. The selection focused on publications relevant to airport city spatial design, logistic system integration, transportation infrastructure, PPP financing models, and governance frameworks in airport infrastructure. All selected documents were retrieved from the Scopus database to ensure academic credibility. Inclusion criteria were applied to maintain consistency and scholarly rigor. Selected papers were required to be written in English, published between 2010 and 2024, and classified as peer-reviewed journal articles or conference proceedings. The papers were then screened to ensure coverage across airport city planning, logistic hub operations, and PPP-financed airport infrastructure. This analysis provided a diverse yet thematically aligned body of work that reflects current practices, trends, and theoretical developments in the field.

A meta-analysis of 20 selected papers was done to map their coverage of eight independent variables: aeronautics services (X1), non-aeronautics services (X2), logistics systems (X3), transportation systems (X4), infrastructure planning (X5), land use (X6), sustainability (X7), and PPP (X8), as well as three dependent variables: efficiency and

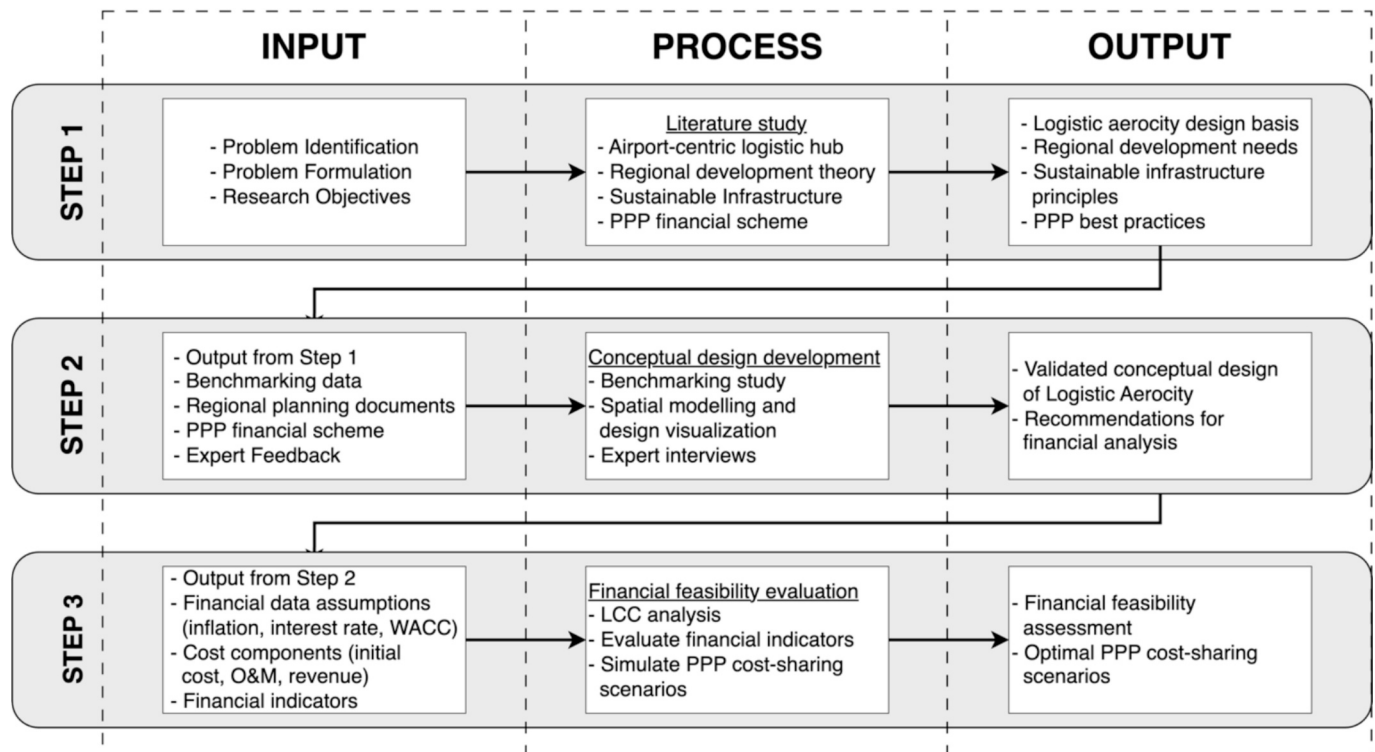


Fig. 1. Research Steps for Developing and Evaluating the Logistic Aerocity.

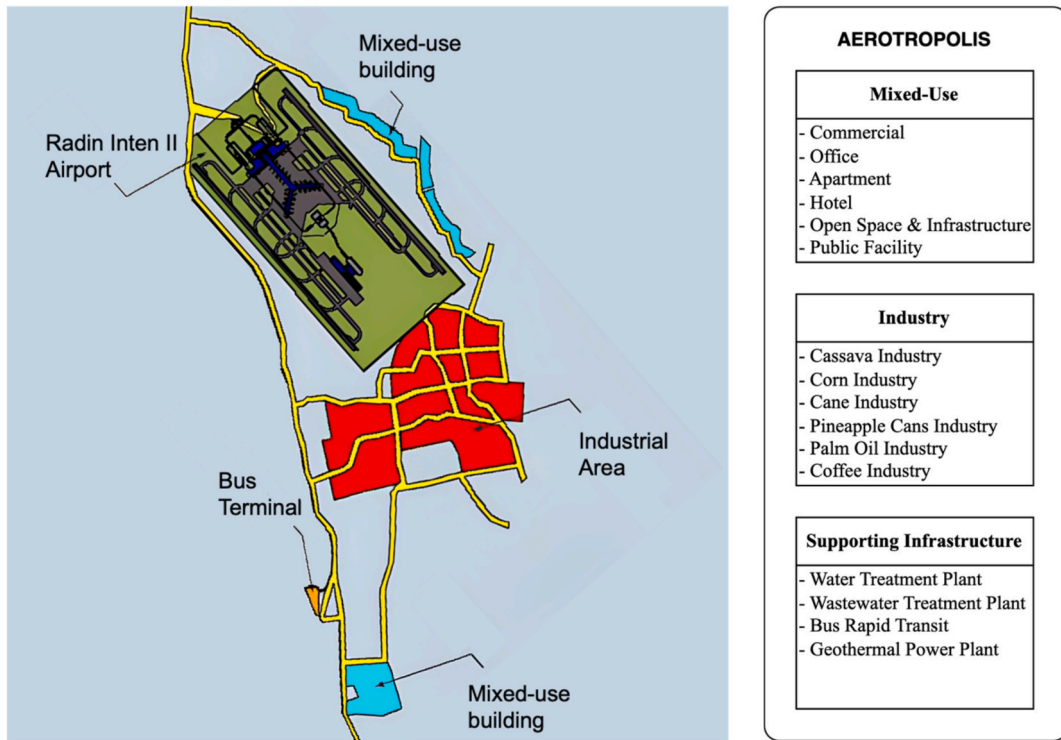


Fig. 2. Radin Inten II Airport with Aerotropolis Development (Berawi et al., 2017).

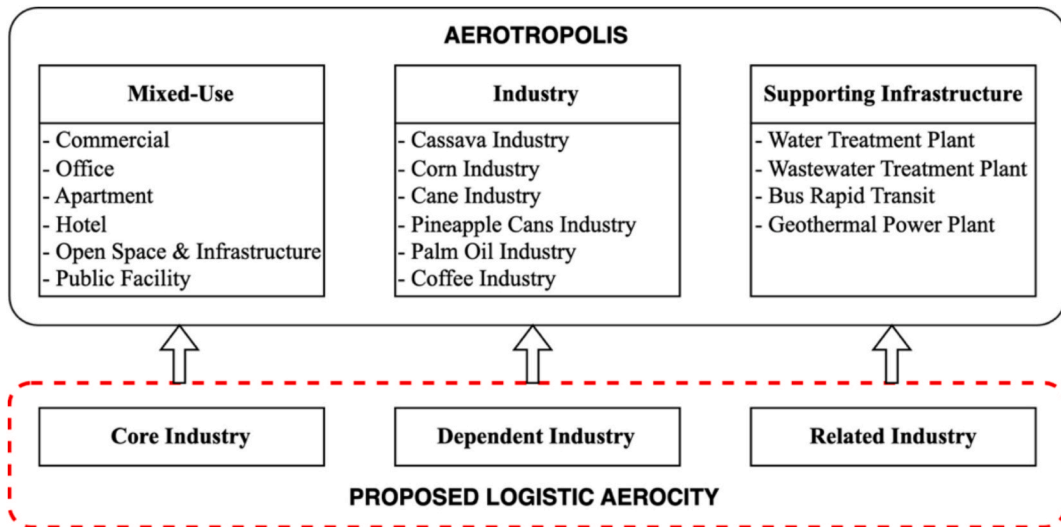


Fig. 3. Relationship between Logistic Aerocity and Radin Inten Aerotropolis.

effectiveness (Y1), financial feasibility (Y2), and economic development (Y3). A binary coding scheme was applied to each paper to indicate the presence or absence of relevant variables. The results were compiled into Table 1, which summarizes how the selected studies address these variables and provides the foundation for the conceptual framework illustrated in Fig. 4.

The conceptual framework links the variables identified in the meta-analysis with the research objectives by illustrating how the functional zones of the Logistic Aerocity, such as the air cargo facility, integrated logistics hub, industrial park, and commercial area, respond to both design and financial parameters.

This framework informed the conceptual design process by mapping how each thematic variable contributes to the configuration of

functional zones, spatial layout, integration strategies, and PPP structure. For instance, variables related to logistics systems, land use, and transportation (X3, X4, X6) shaped the spatial arrangement of facilities, while PPP-related variables (X8) and financial feasibility indicators (Y2) informed the structure of the cost-sharing model. By grounding the framework in this synthesis of literature, the study established a coherent link between academic theory and the proposed design-financing strategy for the Radin Inten Logistic Aerocity. The meta-analysis served as the empirical basis for aligning the design process with established academic insights and allowed the research to maintain conceptual coherence between literature, framework development, and design outcomes.

Table 1
Key variables in studies on airport cities, Logistic Hubs, and PPPs.

Topic	No.	Articles	X1	X2	X3	X4	X5	X6	X7	X8	Y1	Y2	Y3
Airport cities	1	Peneda et al. (2011)	✓	✓		✓	✓	✓	✓				✓
	2	Freestone & Baker (2011)	✓	✓		✓	✓	✓	✓	✓	✓		✓
	3	Appold & Kasarda (2011)	✓	✓		✓	✓	✓					✓
	4	Freestone & Wiesel (2014)	✓	✓	✓	✓	✓	✓					✓
	5	Nasution et al. (2017)				✓	✓	✓			✓		
	6	Liou et al. (2018)	✓	✓	✓	✓	✓	✓	✓		✓		✓
	7	Gierczak-Korzeniowska & Kowalczyk (2019)	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	8	Babaoğlu & Kürkcüoğlu (2020)				✓	✓	✓	✓		✓		✓
	9	Drjjača et al. (2020)	✓	✓	✓	✓	✓	✓	✓				✓
Airport logistic hub	10	Lima et al. (2010)			✓	✓			✓	✓	✓		✓
	11	Boloukian & Siegmann (2016)	✓	✓	✓	✓	✓	✓					
	12	Coetzee & Swanepoel (2017)			✓	✓	✓	✓			✓		
	13	Fernández et al. (2022)	✓	✓	✓	✓	✓				✓		
	14	Xiao et al. (2021)			✓	✓	✓		✓		✓		
PPPs in airport development	15	Cruz & Marques (2011)	✓	✓								✓	
	16	Fuerst et al. (2011)	✓	✓								✓	
	17	Carnis & Yuliawati (2013)	✓	✓			✓			✓	✓	✓	✓
	18	In et al. (2017)	✓	✓				✓		✓	✓		
	19	Berawi et al. (2018)	✓	✓						✓	✓	✓	✓
	20	Berawi et al. (2019)	✓	✓		✓	✓	✓		✓	✓	✓	✓

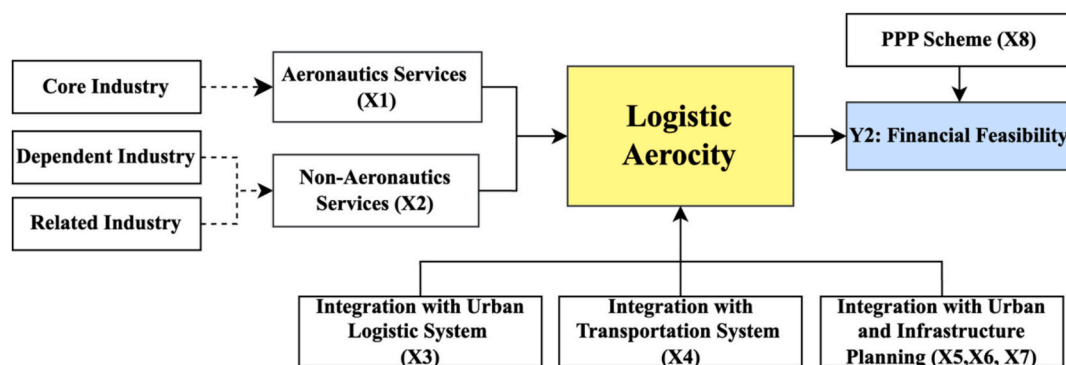


Fig. 4. Conceptual Framework for Logistic Aerocity Conceptual Design Development.

3.2. Logistic Aerocity’s conceptual design development

3.2.1. Benchmarking study

Benchmarking was employed to evaluate existing airport city models, particularly focusing on Incheon International Airport (ICN). This airport was selected because it is a hub in Asia’s emerging market and is recognized as a leading aeronautical and cargo center (Shamohammadi et al., 2022). ICN handled approximately 2.95 million tons of cargo in 2022, with 38 % attributed to transshipment cargo. The development of airport-based commercial and logistics zones includes modern cargo facilities, such as the 338-hectare Free Trade Zone, which achieved 90 % occupancy and supports over 300 companies. The integration of intermodal transportation enhances accessibility to critical areas, exemplified by a USD 2.3 billion, 21.4-kilometer bridge connecting the airport to Songdo International Business District and integrating road, rail, and port infrastructure (Kasarda and Chen, 2021). ICN aerotropolis has attracted over USD 35 billion in investments by integrating logistics hubs and business districts (Kasarda, 2020).

3.2.2. Zoning regulation for land use plan

The land use plan adopts a zoning-based framework to ensure efficient use and sustainable development by incorporating aviation-dependent activities, inter-zone connections, and specific land requirements. Zoning regulations define classifications, regulate utilization intensity, and set infrastructure requirements to obtain optimal land allocation. Building height complies with Indonesia’s Ministry of Transportation Regulation No. KM 44 of 2005 on the Aviation Operation

Safety Zone ensuring flight safety (see Fig. 5). Further analysis is supported by comprehensive secondary data, including regional economic profiles, demographic data, transportation statistics, and road network maps, sourced from Lampung’s Regional Development Planning Agency and Central Statistics Agency. Technical data, such as the Airport Master Plan, air traffic trends, and demand forecasts, were sourced from the Ministry of Transportation and PT. Angkasa Pura II, a state-owned enterprise working in airport services.

The concept design of Logistic Aerocity for Radin Inten II International Airport developed in this study was adapted from Setyawati et al. (2023) (see Fig. 6).

3.2.3. Spatial modeling and Visualization

Spatial modeling was conducted using AutoCAD, Google SketchUp, and Lumion to refine and visualize spatial relationships between the zones within the Logistic Aerocity. The simulations calculated dimensions, volumes, and land compositions to ensure alignment with development goals. The 3D visualizations supported iterative design improvements to harmonize zones and enhance operational feasibility.

3.2.4. In-depth interviews with experts

Experts in urban and airport planning, and infrastructure development were consulted to validate the proposed design, identify adjustments, and provide recommendations. Each expert held a minimum of a master’s degree and had over ten years of professional experience. Their feedback contributed to refining the conceptual model by addressing implementation challenges and ensuring alignment with regional

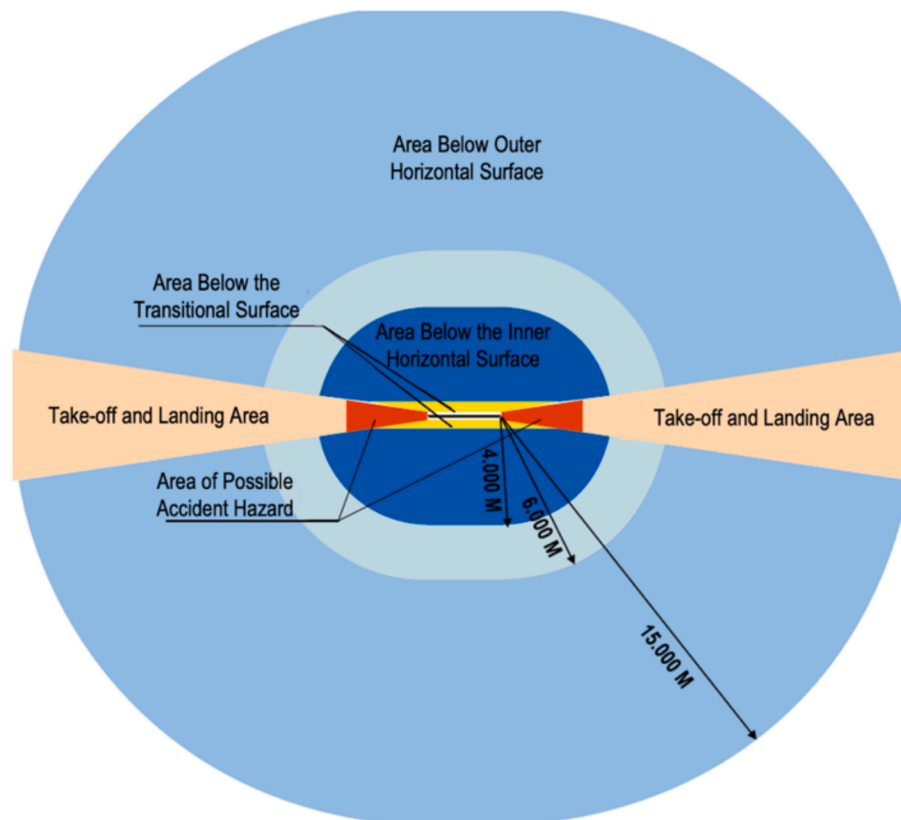


Fig. 5. Aviation Operation Safety Zone (Setyaji et al., 2020).

policies and practical feasibility. Each interview followed a semi-structured format and covered several themes related to the proposed Aerocity development. The initial questions focused on validating the spatial concept, including whether the proposed design aligned with airport-centric development principles and whether the allocation and scale of functional zones were appropriate. The second set of questions assessed the alignment of land use and zoning allocations with national and regional spatial plans and identified necessary regulatory adjustments to support implementation. Additional questions addressed integration with broader regional objectives, such as economic corridors and multimodal transport systems, as well as potential conflicts with existing or planned infrastructure.

The final questions sought expert views on the implementation feasibility and the potential application of a PPP scheme of the proposed Aerocity. Table 2 summarizes the experts involved in the interviews in this study. To process the interview data, responses were categorized thematically, and insights that appeared across multiple experts were treated as collective recommendations, while differing views were revisited and discussed to refine the conceptual design.

3.3. Financial feasibility evaluation

The third step of the research focused on evaluating the financial feasibility of the proposed conceptual design of the Radin Inten Logistic Aerocity that considers the cost characteristics of the components in the Logistic Aerocity zones, where each component has unique cost structures; thus, an individualized yet integrated approach to cost estimation is required.

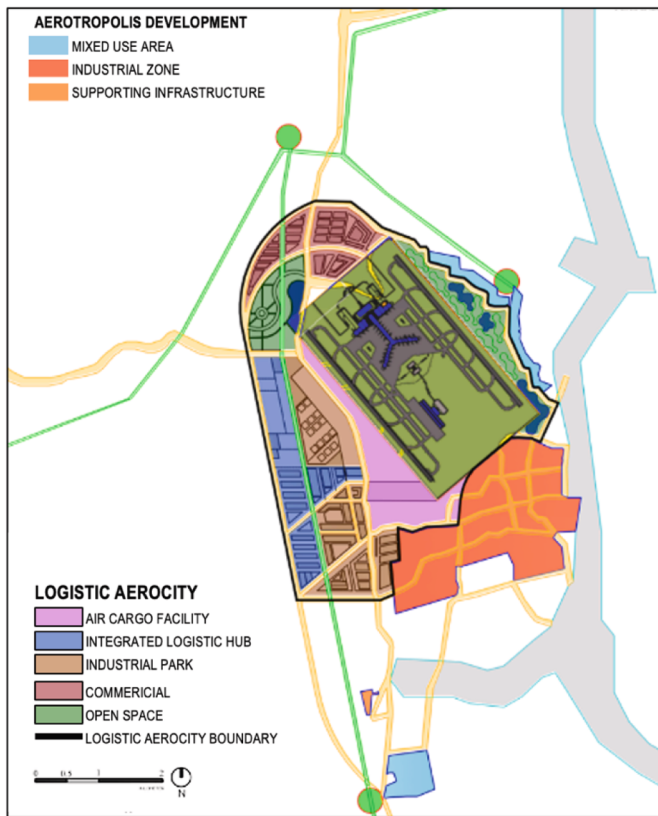
LCC analysis in this study follows a phased implementation approach to ensure that cost estimations align with the gradual development of each component. The LCC approach focuses on three primary cost components: IC, which represents capital investment required for construction and infrastructure development; O&M, which covers expenses

for sustaining aerocity operations throughout its life period; and revenue projections, which estimate income from logistics activities and commercial operations. This analysis ensures a comprehensive evaluation across all project phases (Blank and Tarquin, 2013).

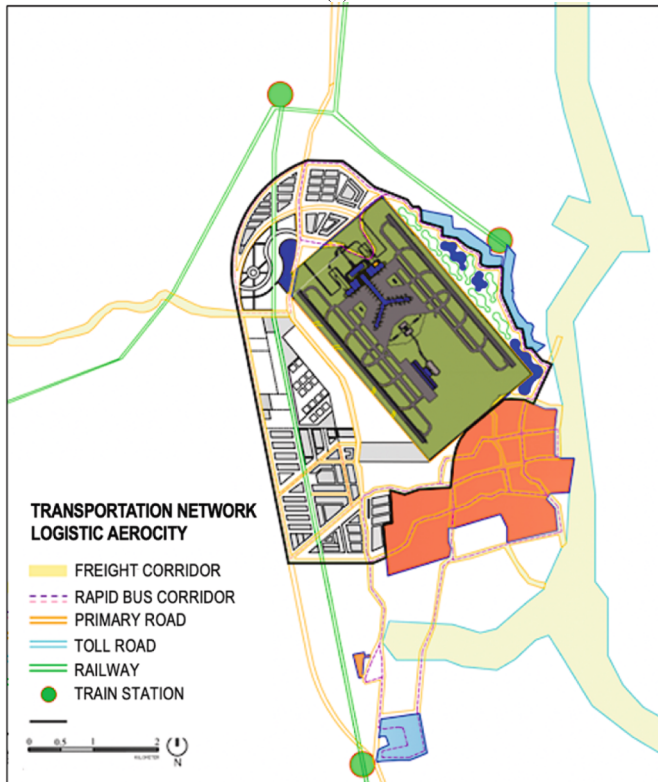
Several assumptions were obtained from academic publications, reports, and studies that discuss cost components across different building types to collect cost components data. Key references, including benchmark-specific standards, local government regulations, and international cost indices, were used to develop a realistic financial evaluation of costs and revenues over the project's life cycle. The details are in Table 3.

To adjust global benchmark costs for the Indonesian context, this study uses a proportional conversion based on Construction Cost Indices (CCIs). The adjustment relies on the ratio between the CCI of the local project site and that of the reference city. For instance, cost data from infrastructure in cities such as London, New Delhi, or Chicago are scaled using relative CCI values to match construction conditions in Indonesia. The indices come from Turner & Townsend (2021) for international cities and Statistics Indonesia (2021) for local municipalities. This approach assumes that construction costs change proportionally with the CCI, which allows the use of relative cost factors (RCFs) to adjust unit prices. For example, if the air cargo facility is benchmarked to London with a CCI of 109.6 and the CCI for Lampung is 92.57, then the RCF is 0.845. This factor is applied to adjust London-based costs to reflect local construction conditions.

This method supports cost estimates that reflect local realities while staying consistent with global benchmarks. Specific CCIs are applied to particular cost component, for example, London for the air cargo facility, Hanoi for the intermodal freight hub, New Delhi for the warehouse complex, Atlanta for the wholesale market, Edinburgh for the distribution center, Chicago for the incubator, Madrid for the golf course, and Boston for the eco-park. For local cases, Makassar is used for the business park and Surabaya for road infrastructure.



(a)



(b)

Fig. 6. Logistic Aerocity adapted from Setyawati et al. (2023): (a) Land Use Plan, (b) Transportation Network.

Table 2
Profile of the experts.

Expert	Current role	Expertise	Experience
Expert 1	Senior Lecturer in Urban and Regional Planning	City and Regional Planning	14 years
Expert 2	Airport Infrastructure Development Manager at a State-Owned Airport Operator	Airport Development	25 years
Expert 3	Private Consultant in Regional Development	Regional Development and Planning	25 years
Expert 4	Senior Policy Advisor for Infrastructure Investment	Infrastructure Investment and PPP	26 years
Expert 5	Senior Researcher in Infrastructure Planning	Infrastructure Planning and Evaluation	15 years

Table 3
Financial assumptions for LCC calculation.

No.	Data	Rate	Reference
1	Discount rate	9.61 %	Bank Indonesia (2023a)
2	General inflation rate	2.6 %	Bank Indonesia (2023b)
3	Real estate sector inflation	2.09 %	Statistics Indonesia (2023)
4	Transportation sector inflation	1.66 %	
5	Recreation and sports sector inflation	2.32 %	
6	Health sector inflation	2.81 %	
7	WACC for the construction sector	11 %	Henrico & Permatasari (2018)
8	Construction Cost Index (CCI)		Turner & Townsend (2021)
	Jakarta, Indonesia	23	
	London, UK	109.6	
	Hanoi, Vietnam	100	
	New Delhi, India	21.5	
	Atlanta, USA	15.8	
	Edinburg, Scotland	69.7	
	Chicago, USA	98	
	Madrid, Spain	91.6	
	Boston, USA	105.4	
9	CCI of Indonesia's Municipality		Statistics Indonesia (2021)
	Jakarta	121.42	
	Lampung	92.57	
	Makassar	96.84	
	Surabaya	100.84	

3.3.1. Initial cost

Due to the varied nature of the six Logistic Aerocity components, the IC was determined based on global benchmarking, local construction cost adjustments, and sector-specific investment estimates. The calculation involved the following steps:

1) Sector-Specific Investment Components:

The IC breakdown was tailored to each component's development characteristics, such as:

- a. Airport Development involves high-capital infrastructure, such as air cargo facilities
- b. Integrated Logistic Hub consists of freight forwarding centers, intermodal freight hubs, and warehouse complex
- c. Industrial Park accommodates manufacturing zones, research and development centers, and supporting infrastructure
- d. Commercial Area features retail centers, office buildings, and mixed-use developments
- e. Open Space includes community areas with relatively lower investment
- f. Other supporting costs for infrastructure networks are administrative and contingencies.

2) Benchmarking Investment Costs Per Square Meter.

International benchmarks were referenced to estimate the investment cost per square meter based on similar facility standards. For instance, this research used a similar air cargo terminal in Washington DC, United States (Maynard et al., 2015) and considered landside and airside facilities from Gatwick International Airport in the United Kingdom (Ijeh, 2015).

Given the limited availability of local data, this benchmarking approach was crucial for establishing reliable estimates. The 2021 CCI was utilized to compare expenses across:

- a. Global Cities: New York, London, Atlanta, Edinburg, Chicago, Madrid, and Boston.
 - b. Regional Comparisons: Hanoi, New Delhi
 - c. Indonesian Cities: Jakarta, Makassar, Lampung, and Surabaya
- 3) Adjusting for Local Market Conditions

The IC was refined by calibrating global benchmarks with local construction cost indices.

4) Estimating Total Initial Cost

Multiplying the benchmark investment cost by the land area and the Floor Area Ratio (FAR) to estimate total ICs so that the expenses can accurately reflect market conditions for construction in the case study while maintaining alignment with international standards.

3.3.2. OM cost forecasting

The O&M cost represents recurring expenditures needed for maintaining, operating, and managing infrastructure over its lifecycle. The method for its estimation follows these steps:

1) Sector-Specific Cost Variability.

The O&M cost structure differs across components. Airport facilities require extensive maintenance for runways and terminals, whereas logistics hubs incur warehouse management and freight operations costs. The real estate and commercial sectors involve costs associated with facility management, utilities, and security, while open spaces have relatively lower but continuous maintenance expenses.

2) Annual O&M Cost Growth Adjustments:

Inflation adjustments were incorporated based on historical trends and sector-specific inflation rates in Table 3.

3) Phased O&M Cost Implementation:

O&M expenses were projected to increase proportionally as infrastructure phases become operational. Cost escalation trends were analyzed using historical data, inflation trends, and industry benchmarks. The final O&M cost model ensures operational expenses align with revenue generation and development schedules.

3.3.3. Revenue Projection

Revenue projections were developed to evaluate the economic consideration of each component. The revenue analysis followed a two-stage approach:

1) Identification of Revenue Streams by Sector:

- a. Airport Development: passenger fees, air cargo handling charges, airline services.
- b. Integrated Logistic Hub: warehouse rental fees, logistics service fees, freight handling income.
- c. Industrial Park: Lease agreements, production-based fees, manufacturing hub revenue.

- d. Commercial Area: Retail rentals, office leases, business operations income.
 - e. Open Space: Clubhouse income.
- 2) Annual Revenue Growth Adjustments:
- a. Revenue growth was modeled based on historical financial data, inflation rates, and projected demand elasticity for each sector.
 - b. Inflation-adjusted revenue projections to ensure that income can offset O&M costs.

3.3.4. Financial modelling

The LCC analysis employs three key financial metrics to evaluate the project's feasibility: Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PB). NPV measures the difference between the present value of cash inflows and outflows to determine profitability. A project is considered feasible if $NPV > 0$. The formula for NPV is as follows:

$$NPV = \sum_{t=0}^n \frac{(R_t)}{(1+i)^t} \tag{1}$$

where R_t is the net cash flow during a time t , i is the discount rate, and t is the number of cash flow periods.

The IRR identifies the discount rate at which NPV is zero. It evaluates whether the investment reaches the required rate of return (Strano et al., 2013). The IRR equation is expressed as:

$$IRR = i_1 + \frac{NPV_1}{(NPV_1 - NPV_2)} (i_2 - i_1) \tag{2}$$

where i_1 is the lower discount rate chosen $NPV_1 = NPV$ at i_1 , and i_2 is the higher discount rate chosen $NPV_2 = NPV$ at i_2 .

Then, PB calculates the time required to recover the investment from an asset's net cash flows.

3.3.5. Cost-sharing scenarios

Financial engineering simulations were conducted to assess the investment feasibility through LCC analysis and to explore alternative cost-sharing scenarios within a PPP framework. This study applies four distinct cost-sharing schemes between the public and private sectors, with each scheme representing different arrangements for IC, O&M costs, and revenue distribution, as summarized in Table 4.

These four base schemes were expanded into 42 cost-sharing scenarios by assigning different proportions of public and private contributions (see Table 5). IC and O&M costs were examined at contribution levels of 40 %, 50 %, and 60 %, while revenue-sharing ratios were set at 60 %, 70 %, and 80 %. These ratios follow Minister of Finance Regulation No. 223/PMK.01/2012, which defines cost-sharing principles and flexibility ranges for public contributions in PPP infrastructure projects in Indonesia. These proportions in PPP financing are supported by several studies, such as Chen et al. (2015) describe a typical 7:3 debt-to-equity ratio used to maintain financial stability and investor interest. Demirel et al. (2022) also report that infrastructure projects often adopt debt ratios of 80:20 or 90:10 to accommodate high capital needs and long recovery periods.

To structure the analysis, the 42 scenarios were grouped into four models: (1) IC-Sharing with public contributions of 40 %, 50 %, and 60

Table 4
Four different scheme scenarios.

Scheme	IC Contribution	O&M Cost Contribution	Revenue Distribution
IC Sharing	Shared	Private	Private
O&M Cost Sharing	Private	Shared	Private
IC + O&M Cost Sharing	Shared	Shared	Private
IC + O&M Cost + Revenue Sharing	Shared	Shared	Shared

Table 5
42 PPP financing scenarios.

IC Sharing Scenario	Public	Private	IC Split + O&M Sharing + Revenue Sharing Scenario	Split IC	O&M Sharing	Revenue Sharing
1	60 %	40 %		Private	Private	Private
2	50 %	50 %	16	40 %	40 %	60 %
3	40 %	60 %	17			70 %
			18			80 %
O&M Sharing Scenario	Public	Private	19		50 %	60 %
4	60 %	40 %	20			70 %
5	50 %	50 %	21			80 %
6	40 %	60 %	22		60 %	60 %
			23			70 %
			24			80 %
Split IC + O&M Scenario	IC	O&M	25	50 %	40 %	60 %
	Public	Private	26			70 %
7	40 %	40 %	27			80 %
8		50 %	28		50 %	60 %
9		60 %	29			70 %
10	50 %	40 %	30			80 %
11		50 %	31		60 %	60 %
12		60 %	32			70 %
13	60 %	40 %	33			80 %
14		50 %	34	60 %	40 %	60 %
15		60 %	35			70 %
			36			80 %
			37		50 %	60 %
			38			70 %
			39			80 %
			40		60 %	60 %
			41			70 %
			42			80 %

%; (2) O&M–Sharing with similar ratios; (3) Combined IC + O&M models involving nine variations; and (4) Revenue-Sharing models, which include 27 scenarios with revenue retained at 60 %, 70 %, or 80 % by the private sector. All scenarios were simulated to assess IRR, NPV, and PB, and the most viable scheme was selected based on its ability to meet financial feasibility criteria.

This analysis determined the validity and practicality of the research findings, providing a solid foundation for the proposed financial model. The research workflow is shown in Fig. 7.

4. Result and discussions

2.1. Conceptual design of Logistic Aerocity

The transportation network infrastructure in the conceptual design of Radin Inten Logistic Aerocity consists of a road network, railways to increase freight capacity and ease road congestion, bus rapid transit (BRT) corridors along arterial roads connected to toll roads to improve public transit access, and multimodal freight corridors that integrate road and rail corridors. The integration of the land use plan and transportation network ensures optimal space utilization and operational efficiency; however, aviation safety regulations should also be adhered to. Building on the proposed framework shown in Fig. 6, Fig. 8 demonstrates how zoning and infrastructure align with these safety regulations. Logistics hubs, industrial parks, and commercial zones are positioned outside restricted areas, while multimodal corridors are planned to minimize interference with critical air operations.

a. Air Cargo Facility

The Air Cargo Facility is part of the airport development and is designed to optimize air cargo logistics and enhance supply chain efficiency. It integrates air, land, and potentially sea transportation systems to ensure seamless connectivity for goods movement.

The facility includes core infrastructure such as runways, cargo terminals, customs facilities, and supporting elements like warehouses, cold storage, logistics hubs, and security systems. The size of land (195

ha) allocated for each sector has influenced the investment structure, with the largest plots designated for airside facility (65.74 %), followed by terminal and warehouse (23.87 %), and landside facility (10.40 %).

Sustainability is addressed through energy-efficient buildings, renewable energy integration, water recycling, and waste management. Green logistics initiatives, such as low-emission transportation and measures to reduce air pollution and noise, ensure responsible operations. Economically, the facility attracts investments, creates jobs, reduces business costs, and enhances trade facilitation, supporting regional development. The visualization of the Air Cargo Facility is depicted in Fig. 9.

b. Integrated Logistic Hub

Building on the connectivity established by the Air Cargo Facility, the Integrated Logistic Hub is designed to facilitate a wide range of logistics activities, including inventory management, packing, distribution, and goods delivery. It also supports reverse logistics, warehousing, and storage operations alongside value-added services such as consolidation, maintenance, customs processing, final assembly, and repairs.

The Integrated Logistic Hub comprises several components with specific land uses to support logistics activities. The Freight Forwarding Center includes a Consolidation and Distribution Area that handles consolidation, cross-docking, storage, replenishment, and pre-retailing of goods.

The Integrated Freight Complex (IFC) includes a Wholesale Market serving commodities for specialized trade needs. The Inland Intermodal Freight Hub features Intermodal Terminals, Container Freight Stations (CFS), Container Yards, Customs and Control Centers, vehicle waiting areas, and workshops for container repair. Additionally, the Warehouse Complex provides general and specialized storage, including cold chains, hazardous goods, and bonded warehouses tailored to the characteristics of the goods.

The hub is near the airport and Panjang International Export Port and optimizes air and sea transportation connectivity. Warehouses are equipped for conventional storage and build-to-suit facilities to support local and international e-commerce operations and industrial raw

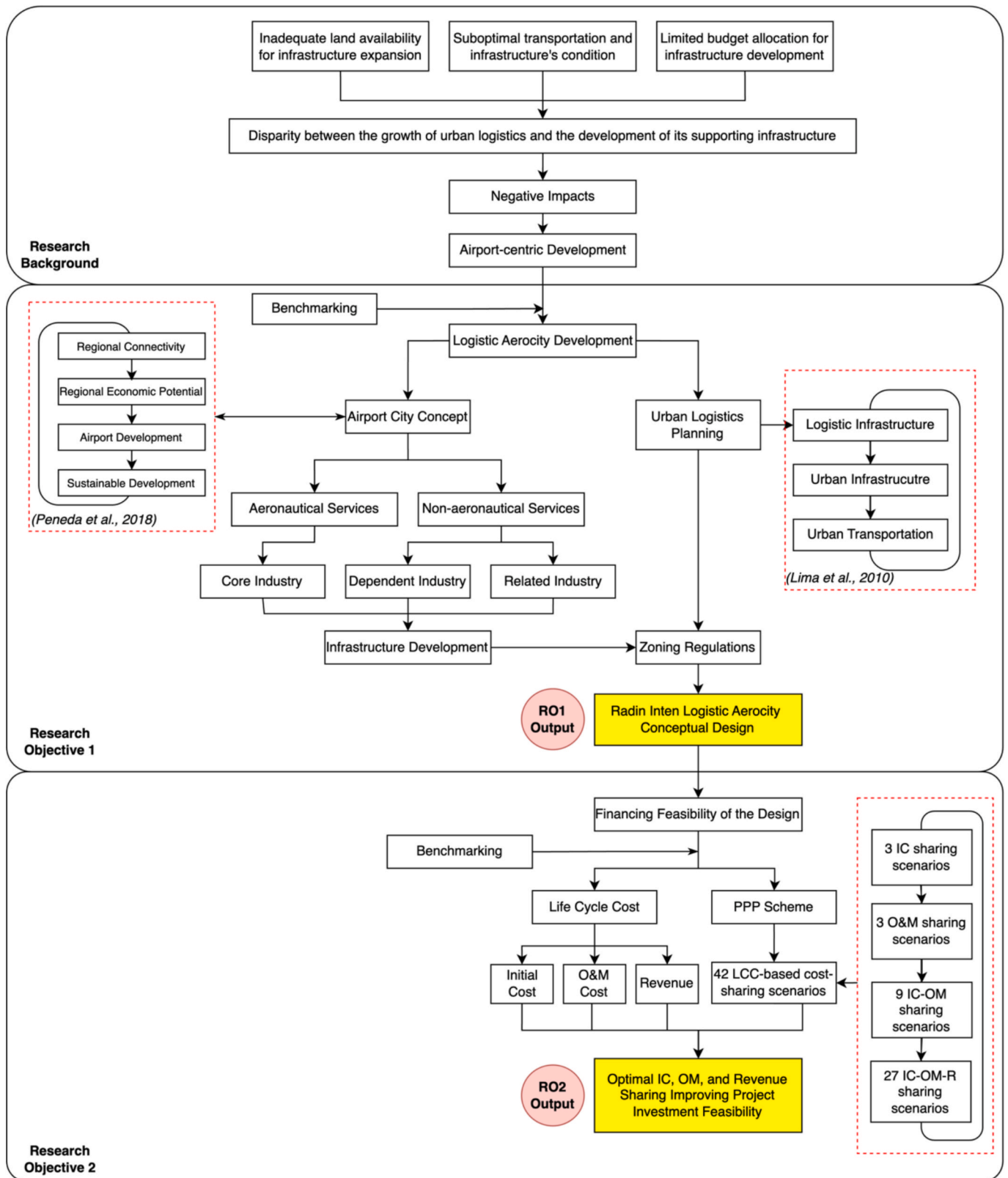


Fig. 7. Research Workflow.

material storage. Fig. 10 illustrates the development's land use and building types, while Fig. 11 visualizes its design.

c. Industrial Park

The Industrial Park is designed to enhance industrial value by producing value-added and time-sensitive products. It hosts key industries, including Pharmaceutical Manufacturing for medical drugs, biotechnology research, and health-related innovations. Furthermore, it also has Aviation Maintenance, Repair, and Overhaul (MRO) services for

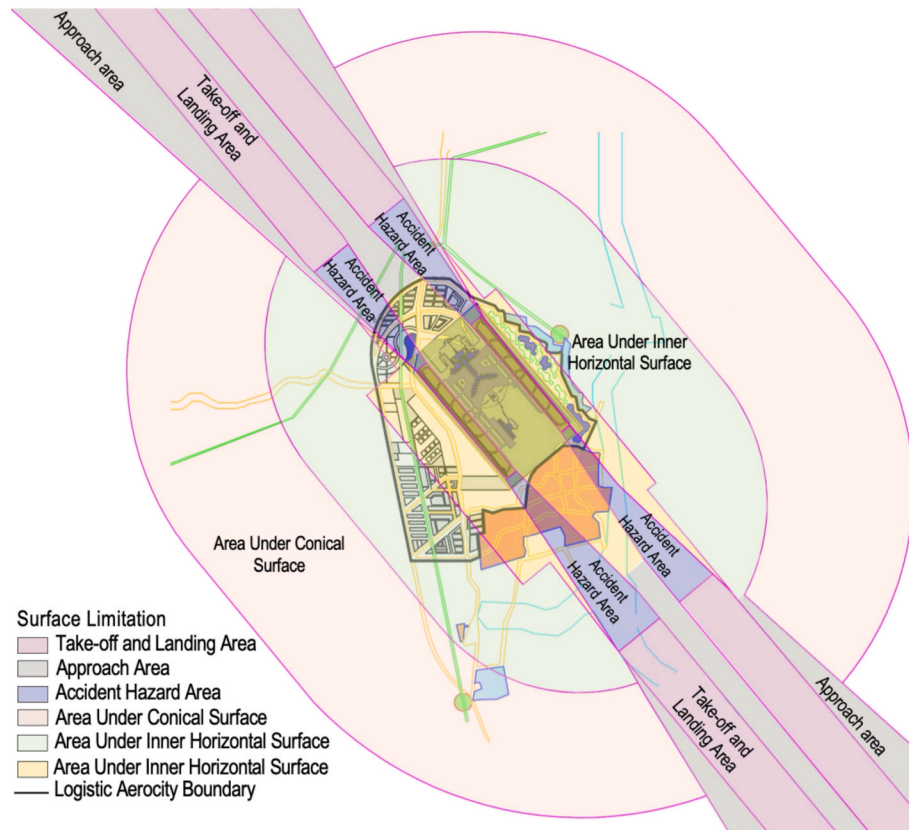


Fig. 8. The intensity of space utilization within the Radin Inten (. Source: Authors' Analysis)



Fig. 9. Air Cargo Facility: Land Use, Building Types, and Design Visualization.

regular and unscheduled maintenance for aviation, heavy machinery, and industrial equipment, which support regional and international logistics operations. Additionally, an Incubator supports manufacturing by creating a research-driven industrial ecosystem that encourages innovation, technology transfer, and startup development. This sub-component attracts private investment, university partnerships, and

corporate R&D funding, further driving knowledge-based economic growth.

Essential infrastructure is designed to ensure a safe and efficient environment, which includes industrial support facilities, wastewater treatment plants (WWTP), and emergency evacuation routes. The design of the Industrial Park is illustrated in Fig. 12 that shows its various

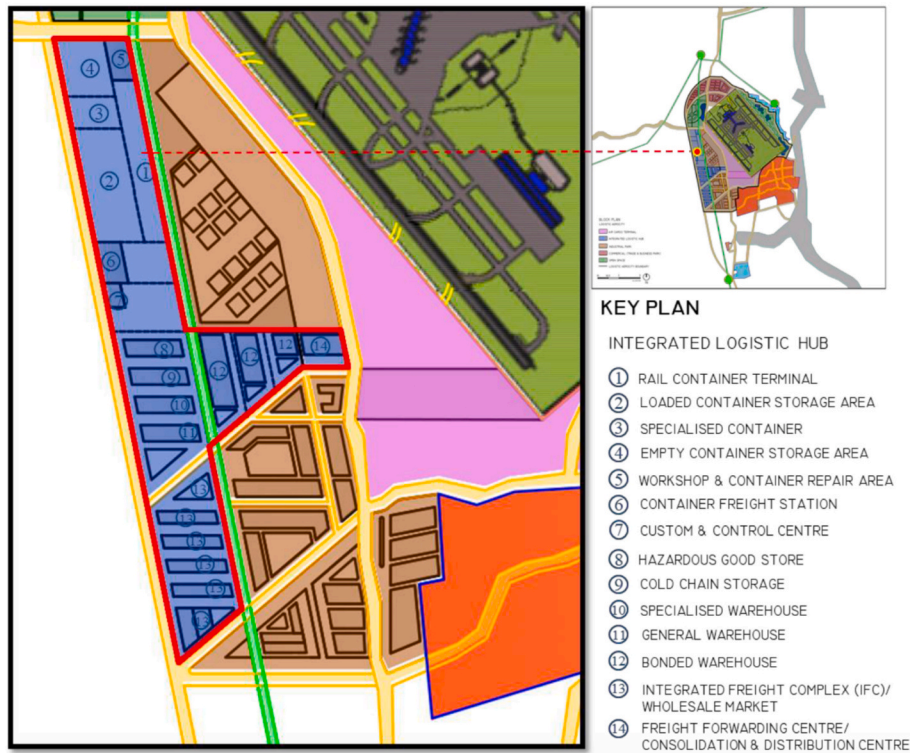


Fig. 10. Integrated Logistic Hub's Land Use and Building Types.

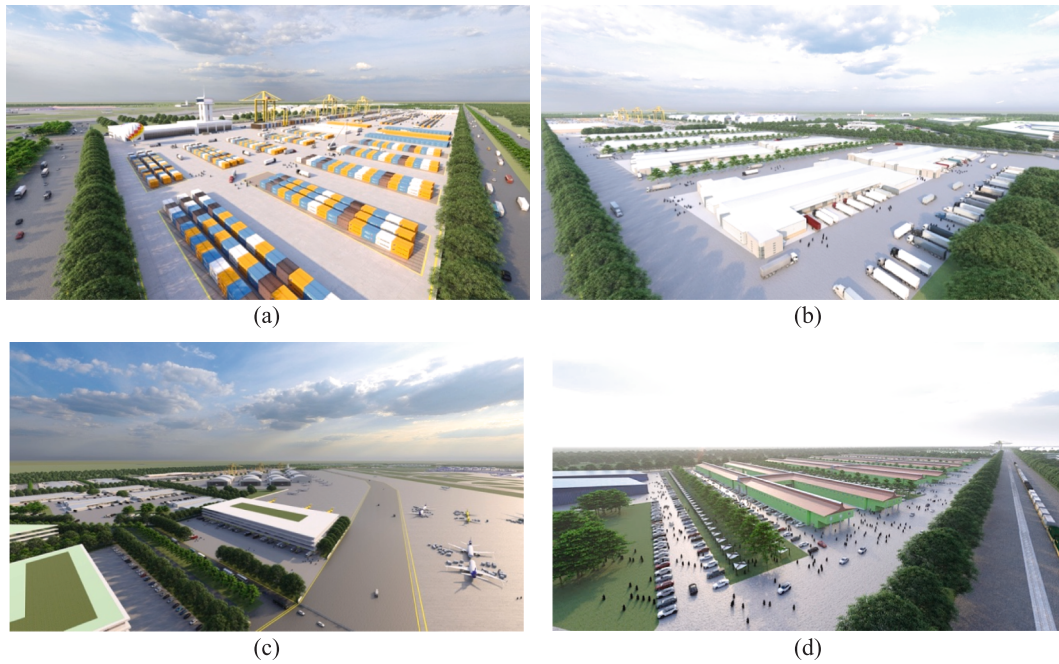


Fig. 11. Design Visualization of the Integrated Logistic Hub: (a) Inland Intermodal Freight Hub; (b) Warehouse Complex; (c) Consolidation Center; (d) Wholesale Market.

components and layout.

d. Commercial Area

The Commercial Area within the trade and business park is designed to support airport-centric trading and service businesses. It has three sub-components: Mall and Retail Outlet, Office Park, and Expo Center.

The Mall and Retail Outlet can serve local consumers and transit passengers with retail stores, dining, and entertainment, positioned to capitalize on the high foot traffic from the airport, industrial park, and logistics hub. The Office Park provides corporate offices, business centers, and co-working spaces to attract multinational corporations and logistics firms due to its strategic location and connectivity to key aerocity facilities. The Expo Center hosts conventions, trade fairs, and



Fig. 12. Design visualization of industrial park: (a) pharmaceutical manufacturing; (b) MRO facilities; (c) incubator; (d) aerial view.

exhibitions, driving business tourism and investment opportunities while reinforcing the logistic aerocity’s role as a regional trade and logistics hub. Fig. 13 shows the design visualization of the Commercial Area.

e. Urban Open Space

The Urban Open Space provides public areas and social infrastructure, featuring an eco-park with an urban plaza, recreation pond, community plaza, garden restaurant, and a leisure area with a golf course. This space also functions as a local protected area with a vital water catchment role that helps manage stormwater, reduce flood risks, recharge groundwater supplies, and conserve the environment.

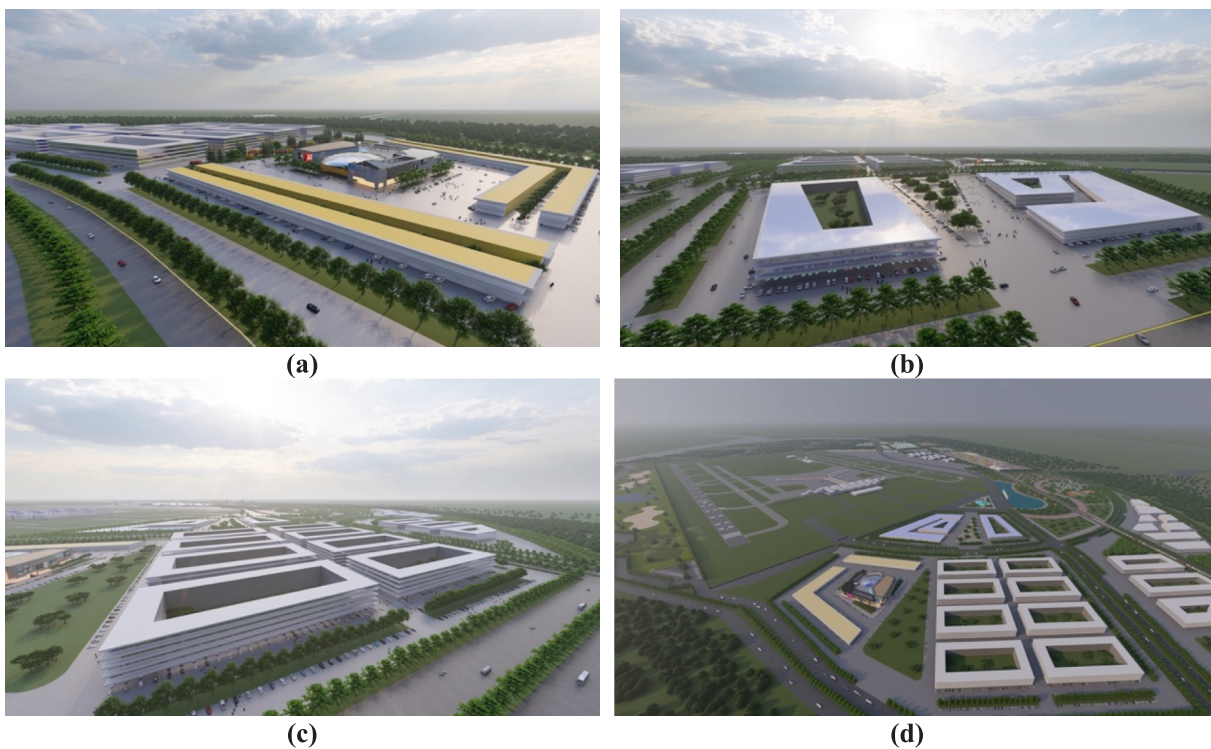


Fig. 13. 3D Visualization of Commercial Area: (a) Mall & Retail Outlet; (b) Expo Center; (c) Office Park; (d) Aerial View.

The restaurant sector caters to tourists, business travelers, and residents and offers casual dining, fine dining, and food court options. Plazas and Ponds serve as community spaces with green areas, walking paths, and open areas for public events and outdoor activities, which enhance urban aesthetics and support commercial activities through sponsorships and vendor leases. As a premium attraction, the Golf Course spans 118.11 ha and adheres to international standards for 18-hole championship courses. This scale enables hosting high-profile tournaments, attracting affluent users, and generating substantial revenue through memberships, events, and ancillary services.

Environmentally, the Urban Open Space integrates natural features and ecological functions into its design to mitigate urban environmental impacts. Green spaces and landscaped ponds improve air quality by acting as carbon sinks, while vegetation and shaded areas reduce the urban heat island effect. Native plant species and water-efficient landscaping minimize resource consumption and support local biodiversity. These sustainable design practices align with urban development goals that help balance economic growth and environmental stewardship. The Urban Open Space enhances livability and strengthens the aerocity's commitment to sustainability by preserving and integrating natural ecosystems into the urban environment. Based on these principles, this space's conceptual design is illustrated in Fig. 14.

Expert interviews contributed essential insights that guided the refinement of the Logistic Aerocity's conceptual design. Feedback covered six thematic areas: spatial validation, zoning regulations, regional integration, implementation feasibility, sustainability, and potential PPP application. Experts stated that the spatial layout followed airport-centric planning principles and supported efficient co-location of logistics and commercial zones, though two experts raised concerns regarding the proximity of the warehouse and wholesale market, which could create operational inefficiencies. Recommendations included a clearer separation between these functions. Experts also emphasized the need for zoning flexibility to accommodate future shifts in demand or policy.

Experts agreed that the spatial configuration aligned with regional economic goals and multimodal transport priorities. They highlighted

the inclusion of rail and road corridors as a valuable feature that could improve logistical connectivity. However, concerns arose around potential environmental and social impacts, particularly in areas near residential developments. Suggestions included placing buffer zones near sensitive areas and strengthening spatial controls to support environmental performance. On the topic of implementation feasibility, experts pointed to land acquisition and coordination across institutions as key barriers. They agreed that discussions with local and national agencies early in the planning stage are needed in order to accelerate permits and reduce administrative delays.

In the area of sustainability, experts proposed expanding the framework to include both social and economic outcomes. These included job accessibility, equitable service distribution, and infrastructure resilience. Specific improvements included the use of environmentally responsible materials and the design of infrastructure that can adapt to external stresses such as climate variability. On the financing side, all five experts expressed support for a PPP model. However, they cautioned that the proposed scheme must comply with relevant laws, distribute risks equitably, and include sufficient institutional capacity for contract oversight. Public involvement through stakeholder consultations was also recommended to align sectoral policies and balance public-private interests.

The interviews led to several adjustments in the Aerocity's spatial and financial strategy. Revisions addressed spatial relationships among zones, added mechanisms for regulatory adaptation, and strengthened environmental safeguards. In addition, insights on PPP implementation guided changes in revenue sharing, risk distribution, and stakeholder roles. These outcomes reflect an integrated approach that incorporates expert knowledge across disciplines to strengthen the practical and policy relevance of the final development model.

4.2. Financial analysis

4.2.1. Stages for development

The calculation of the IC, O&M Cost, and Revenue components was strategically aligned with the Radin Inten Logistic Aerocity development

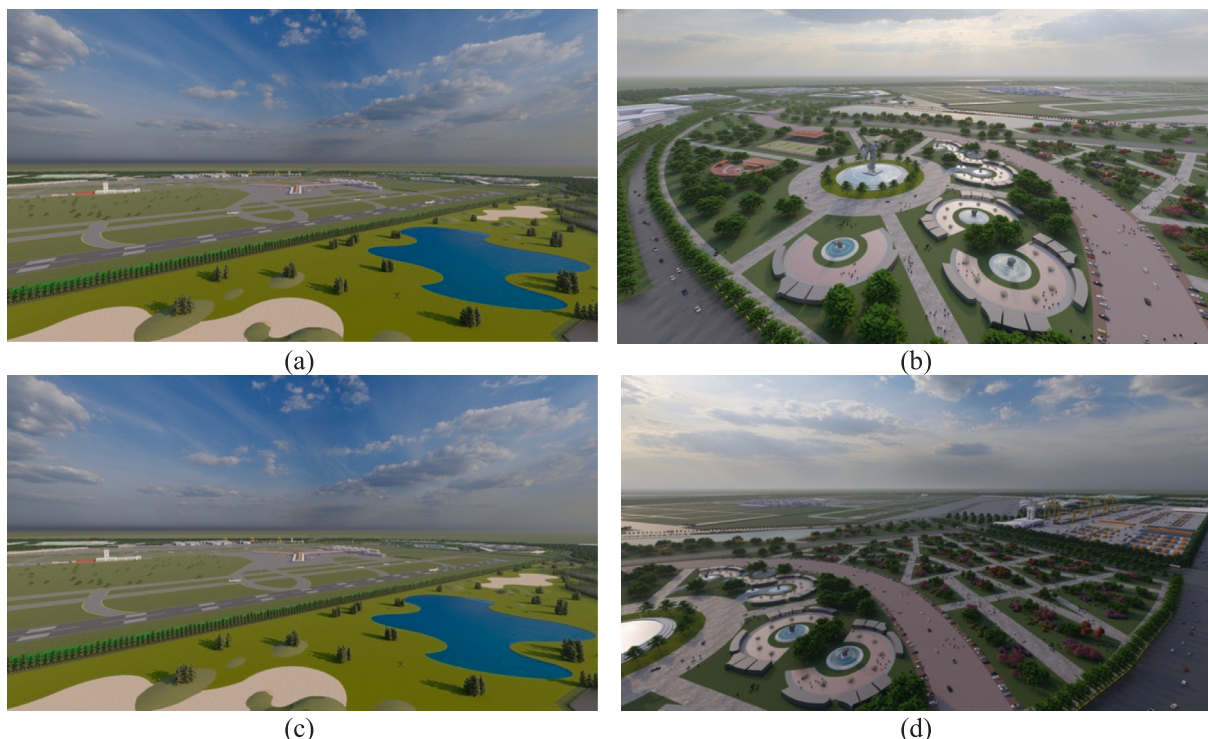


Fig. 14. Visualization of Open Space Area: (a) Golf Course; (b) Community Plaza; (c) Urban Plaza & Recreation Pond; (d) Garden Restaurant.

plan. The construction sequencing aligns with each zone’s functional priorities, optimizing cash flow management, infrastructure readiness, and revenue realization over time. The phased implementation is as follows:

1. Phase 1 – Foundational Development (2025–2026): Airport Phase 1, Mixed-Use Phase 1, Industrial Area, Business Park, Eco Park, and supporting infrastructure.
2. Phase 2 – Expansion of Key Sectors (2027–2030): BRT corridors, Pharmaceutical Industry, and Incubator/Discovery Park in 2027. Intermodal Freight Hub, Warehouse Complex, Wholesale Market, Air Cargo Facility, and MRO Industry in 2028–2029. Airport Phase 2, Mixed-Use Phase 2, alongside additional Business and Eco Parks in 2030.
3. Phase 3 – Industrial and Mixed-Use Expansion (2033–2038): Industrial Areas in 2033, BRT expansion and Mixed-Use Phase 3 in 2035, followed by Airport Phase 3 in 2038.
4. Phase 4 – Finalization and Optimization (2040–2046): Mixed-Use Phase 4 with BRT system expansion in 2040–2045 and completion of Airport Phase 3 in 2046.

4.2.2. Life cycle cost (LCC) analysis

This section presents the LCC analysis for the Radin Inten Logistic Aerocity by integrating the IC, O&M Cost, and Revenue components. The analysis combines a macro-level financial overview with a detailed component-specific breakdown to provide a holistic view of financial feasibility.

4.2.2.1. Macro-Level financial overview. The total IC for the Radin Inten Logistic Aerocity is estimated at USD 1.75 billion, which covers land acquisition, infrastructure development, sector-specific facility construction, and supporting public services (see Table 6). The largest investment is allocated to Airport Development. Other major capital-intensive components include the Integrated Logistic Hub, Industrial Park, and Commercial Area.

Over the project’s lifecycle, O&M costs are projected to increase as facilities become operational, with annual O&M costs expected to reach USD 14.5 billion. The highest operational cost will stem from Airport Development and Industrial Park, while Commercial Area and Urban Open Space require lower maintenance expenditures.

Despite the capital investment and ongoing maintenance requirements, the revenue generation is projected to increase over time, with an initial annual revenue estimate of USD 24.63 billion. The revenue drivers include Airport Development, Integrated Logistics, and Industrial Manufacturing. Additional revenue streams will arise from office rentals, retail leases, and commercial and open space tourism

activities.

4.2.2.2. Component-Specific LCC analysis.

1) Airport Development

Based on the cost estimations that consider benchmarking studies, construction cost indices, and land utilization metrics, the IC required for Airport Development is estimated at USD 253.3 million by 2030. The O&M costs are projected to reach USD 25.1 million annually by 2038, with an estimated USD 18.0 million annually. The logistics and airport sectors contribute the highest maintenance costs, driven by freight handling, security requirements, and airfield operations. Cost escalations are projected in line with sector-specific inflation rates, particularly affecting real estate, logistics, and industrial operations.

Revenue generation plays a key role in financial sustainability, with an estimated income of USD 53.2 million annually, which will increase to USD 73.3 million annually from 2038 onward. This revenue is derived from ground, improved ramp, and facility leases (warehouse, office, and parking lot). The gradual increase in revenue is expected to offset rising O&M costs for long-term financial viability.

2) Integrated Logistic Hub

The IC of the Intermodal Freight Hub is estimated at USD 203.3 million in 2028, which covers civil work, building work, infrastructure, railway, and handling equipment. O&M costs are expected to increase proportionally with freight volume that will reach USD 1.67 million annually by 2033. These costs include rail yard maintenance, freight scheduling systems, energy requirements, and logistics coordination expenses. All of them are estimated to cost 0.82 % from IC. Meanwhile, the revenue for the Intermodal Freight Hub is projected at USD 18.43 million, primarily driven by shuttle train transport fee per TEU (USD 72.97) or per car (USD 97.04), handling fee (USD 15.86) and wharfage (USD 15.05) per TEU or car.

The Warehouse Complex’s IC is estimated at USD 60.7 million by 2028, covering multi-functional warehouse infrastructure, machinery, and equipment. O&M costs are expected to reach USD 11.35 million annually by 2033, accounting for utilities, building, and infrastructure maintenance. Revenue streams include warehouse leasing fees. The total annual revenue is projected at USD 30.27 million, which positions it as a key income-generating segment in the Integrated Logistic Hub.

The IC of the Wholesale Market is estimated at USD 80 million in 2029, which includes the cost of constructing a wholesale market, facilities, and land. The O&M costs are projected to reach USD 4.88 million annually by 2033, considering operating expenses (7 %

Table 6
The results of the calculation of the IC, O&M, and Revenue components.

Zone	Component	IC (USD)	O&M (USD)	Revenue (USD)
1. Airport	Air Cargo Terminal	255,222,863.57	25,090,460.81	74,068,318.63
2. Integrated Logistic Hub	Intermodal Freight Hub	203,213,951.28	1,660,352.89	18,433,011.98
	Warehouse Complex	60,948,008.79	11,346,469.10	30,265,261.87
	Wholesale Market	79,745,711.27	4,882,720.28	23,405,340.00
	Consolidation & Distribution Area	16,782,084.86	3,490,234.69	3,664,746.42
3. Industrial Park	Pharmaceutical Manufacturing	111,978,849.46	266,430,415.59	295,136,555.00
	Incubator/Discovery Park	167,434,831.41	29,283,098.08	53,093,021.34
	MRO	150,269,897.57	125,442,236.22	224,650,308.63
4. Commercial Area	Mall and Retail Outlet	80,730,839.73	4,440,196.19	44,833,947.53
	Office Park	208,446,796.73	5,419,616.71	86,357,319.65
	Expo Center	67,950,780.28	5,651,868.52	17,483,869.89
5. Urban Open Space	Restaurant, Plaza, and Pond	20,616,587.47	1,206,503.21	3,934,675.69
	Golf Course	13,658,194.89	281,666.14	806,262.96
	Road network infrastructure	66,623,449.00	27,084,173.39	–
6. Professional fee (2 % of IC)		28,739,987.95	–	–
7. Administration fee (5 % of IC)		71,849,969.87	–	–
8. Contingency (10 % of IC)		143,699,939.73	–	–
Total		1,747,912,743.85	14,499,386,051.66	24,627,356,143.71

revenue), property management (5 % revenue), insurance, as well building and infrastructure maintenance. Revenue streams are primarily generated from tenant leases with an estimated occupancy rate of about 95 %, which contribute USD 23.41 million annually, with a strong potential for revenue growth as market activity intensifies.

The IC of the Consolidation & Distribution Area is estimated at USD 16.67 million in 2030, which covers the construction of infrastructure, warehouse, and operational systems. O&M costs are expected to rise proportionally with cargo quantity that reaches USD 3.49 million annually by 2038, with vehicles, buildings, and maintenance of facilities as the key cost drivers. The revenue driven by distribution services and retailer memberships is projected at USD 3.66 million per year, with growth potential as trade volumes expand.

3) Industrial Park

The Industrial Park within the development is designed to accommodate Pharmaceutical Manufacturing, MRO services, and an Incubator/Discovery Park like those in Bhutan and India. The development of Pharmaceutical Manufacturing demands significant capital investment due to advanced laboratory facilities, specialized production lines, and regulatory compliance requirements. The IC is estimated at USD 112 million in 2027, which covers the construction of manufacturing plants, laboratory research centers, and quality control facilities. The O&M cost will reach USD 266 million annually by 2038 due to material storage, utilities, fuels, R&D, and overhead. Pharmaceutical Manufacturing is one of the highest-yielding industrial sectors within the aerocity, as bulk pharmaceutical sales drive revenue generation, projected to reach USD 294.67 million per year by 2038.

The Incubator/Discovery Park is estimated to have its IC projected at USD 167.33 million in 2027, with significant allocations for research labs, co-working spaces, technology incubation areas, and collaborative industry-university projects. The O&M cost is expected to grow moderately, reaching USD 29.28 million annually by 2033, which covers facility maintenance, property management, insurance, and supporting infrastructure. The revenue is primarily generated from office and space fees, projected to reach USD 53.09 million by 2033.

The MRO Facilities benefit from their proximity to the airport, logistics hub, and intermodal freight services. The IC is estimated at USD 150 million in 2030, which covers the test cell and high-precision engineering facilities. O&M costs are expected to reach USD 125.33 million annually by 2038, driven by labor-intensive servicing operations, equipment maintenance, and regulatory inspections. Revenue generation is supported by long-term servicing contracts with airlines, manufacturing firms, and logistics operators, projected to reach USD 224.67 million annually by 2038.

4) Commercial Area

The Commercial Area within the development is structured around three key sub-components: Mall and Retail Outlet, Office Park, and Expo Center. The cost structure is based on Jakarta's retail market benchmarks, as analyzed by [Colliers \(2022\)](#).

The Mall and Retail Outlet has an estimated IC of USD 80.67 million in 2025, which covers commercial building construction and retail leasing spaces. The IC of the Expo Center is estimated at USD 68 million to build large-scale event venues in 2025, exhibition halls, and supporting amenities. The IC of Office Park is projected at USD 208.67 million in 2026, which covers office building construction, business infrastructure, and tenant-ready workspaces.

The O&M cost for commercial areas includes facility management, security, energy consumption, commercial maintenance, event space management, and supporting infrastructure, projected to reach USD 16.88 million annually by 2030. The revenue is primarily driven by lease revenue from offices, malls, and expo centers, and it is expected to exceed USD 146 million by 2030.

5) Urban Open Space

The Urban Open Space development includes restaurants, plazas, ponds, and a golf course, each serving distinct purposes and contributing to the project's revenue potential. The restaurant has an estimated IC of USD 9.49 million in 2025 for infrastructure investment, kitchen facilities, and seating areas. While the tenants bear the O&M cost for cleaning, utilities, and facility upkeep, its steady revenue streams include tenant rental fees, with projections indicating an annual revenue of USD 3.33 million by 2030.

Furthermore, the plazas and ponds will have an IC at USD 8.96 million in 2025 to develop landscaping, water features, and pedestrian pathways. The O&M cost for this area is projected at USD 1.21 million annually by 2030, and no revenue is collected from this subcomponent.

On the other hand, Golf Course is one of the key revenue-generating components within the urban space. The IC is projected at USD 13.66 million in 2025 to construct course design, landscaping, clubhouse facilities, and operational infrastructure. The O&M costs are expected to increase steadily to reach USD 0.28 million per year by 2030, driven by landscaping maintenance, irrigation systems, and clubhouse management. Revenue for the golf course is derived from commercial land for the clubhouse, where annual revenue is expected to exceed USD 0.81 million by 2030.

6) Other Costs (Infrastructure & Road Networks)

The supporting infrastructure includes road networks, IT systems, and administrative facilities, requiring USD 60 million in initial investment and an O&M cost of USD 27.08 million per year by 2030. While no direct revenue is generated from this component, it is crucial to improve accessibility, increase property values, and facilitate economic activities in the area.

4.2.3. Financial feasibility Analysis: NPV, IRR, and WACC

An NPV and IRR analysis was conducted to assess the financial viability of the Logistic Aerocity development. Financial projections reveal an NPV of USD 483,852,239 with a PB of 13 years, which demonstrates the project's ability to generate net positive cash flows over its lifespan. The project's IRR, calculated at 11.99 %, exceeds the WACC, which indicates returns that surpass financing costs and affirms the project's financial viability in sectors such as airport logistics, industrial parks, and commercial areas.

Evaluating 42 cost-sharing scenarios for infrastructure development under a PPP framework highlights the need to balance government control with private sector financial risks. While several scenarios achieve higher IRR and shorter PB, long-term sustainability and effective regulation depend on selecting schemes that provide adequate government control while maintaining reasonable financial responsibilities for the private sector.

Among the cost-sharing models analyzed, the IC Sharing scenario places all financial responsibility on the private sector, which grants them control over operations and revenue generation. Although this approach delivers higher IRR and shorter PB, it limits government authority and excludes revenue-sharing mechanisms for public revenue, which weakens long-term public interest alignment. On the other hand, the O&M cost-sharing scenario shifts operational costs to the government while the private sector handles the IC. While this arrangement reduces the financial burden on the private sector, the issue of revenue allocation is not resolved because the government remains financially dependent on external funding sources, and the private sector still assumes significant financial risk. Therefore, despite its potential for high IRR, this scenario does not provide a balanced investment framework for long-term infrastructure, particularly from the investor's perspective.

The IC + O&M Cost Sharing scenario provides a better distribution of financial responsibilities between the public and private sectors. However, because the government receives no share of the project's revenue,

this model lacks long-term fiscal returns for reinvestment and poses limitations for scaling up to larger infrastructure initiatives.

In contrast, the IC + O&M Cost + Revenue Sharing scenario provides a more balanced distribution of risks and returns. Both parties contribute to IC and O&M costs, and the government receives a portion of the revenue. This structure improves public returns, preserves regulatory oversight, and assigns operational risks to private entities better equipped to manage them. Table 7 summarizes each scheme’s characteristics, while Fig 15. presents the comparative financial outcomes across the 42 scenarios.

Several scenarios in the simulation delivered high IRR and NPV outcomes, such as Scenarios such as 7 and 10 ghgz recorded IRRs of 28.15 % and 25.26 % with NPVs of USD 2.95 billion and USD 2.80 billion, respectively. However, these scenarios were structured around full private investment or excluded revenue sharing with the public sector. In contrast, Scenario 39, which falls under the IC + O&M Cost + Revenue Sharing category, balanced financial performance with public interest considerations. With the private sector contributing 60 % of IC and 50 % of O&M costs while retaining 80 % of revenue, it achieves an IRR of 18.58 %, an NPV of USD 1.47 billion, and a 10-year PB. This configuration supports financial viability and maintains strategic involvement by the public sector.

Scenario 39 was selected as the baseline due to its strong financial feasibility and compatibility with public policy goals. However, its initial structure applied the same percentage split uniformly across all project zones, which limited flexibility for implementation. To refine the model, the allocation of costs and revenues was adjusted based on the nature of each component and the roles of respective stakeholders. This refinement produced a more tailored and realistic financing model while retaining the strategic advantages of Scenario 39. Table 8 outlines the updated division of responsibilities between the public and private sectors.

The final PPP scheme maintained the core principles of Scenario 39 but introduced differentiated zone-level cost and revenue shares. This revised configuration achieved an IRR of 15.86 %, an NPV of USD 880.7 million, and retained a 10-year PB. While the financial return was slightly lower than the baseline scenario, the structure addressed equity concerns, enhanced regulatory participation, and supported long-term development objectives. The final scheme met all financial feasibility criteria and created a more balanced framework for public–private collaboration. Table 9 provides a summary of the final cost and revenue distribution.

The refined PPP scheme for the Radin Inten Logistic Aerocity aligns with key findings from earlier studies that emphasize balanced risk-sharing, regulatory control, and long-term viability. Cruz & Marques (2011) highlight two main PPP models in airport development, that include concession-based and institutionalized partnerships. Both models emphasize the need for private sector engagement in financing and operations while the public sector retains regulatory oversight. This structure is reflected in the Aerocity’s financing model, where the private sector assumes investment and operational roles for commercially viable components, and the public sector retains responsibility over critical infrastructure and regulatory zones.

Benmansour (2016) identifies the Build–operate–transfer (BOT) framework as a practical strategy for infrastructure development in emerging markets. The Aerocity’s zone-based financing structure

follows this principle, where the private sector can recover investments while gradually integrating public control. Similarly, Carnis & Yuliyawati (2013) argue for clearly defined public–private roles and strong institutional frameworks in airport PPPs. The approach taken in this study mirrors that recommendation through its allocation of responsibilities by zone, which distributes financial obligations and operational tasks based on each stakeholder’s capacity.

The recommendation by Albalate et al. (2014) for partial privatization is also consistent with the Aerocity’s financing model. By limiting full private control and encouraging shared responsibility, the model addresses both efficiency and public interest objectives. Additionally, In et al. (2017) note that unclear responsibilities can reduce investor motivation in PPP projects. The developed conceptual design of Radin Inten Logistic Aerocity addresses that issue by assigning clear financial and operational roles and maintaining government control in areas that require strategic oversight.

5. Conclusion

This paper addresses the growing infrastructure and financing challenges for logistics development in Indonesia by presenting a conceptual design for a logistic aerocity and evaluating its investment feasibility. Using Radin Inten II Airport in Lampung as a case study, the research applies a mixed-method approach that combines spatial planning, land use analysis, zoning regulation, and financial modeling. The proposed design spans 985.23 ha and includes five integrated zones, including an air cargo facility, a logistics hub, an industrial park, a commercial area, and an urban open space. These components reflect a strategic approach that supports regional logistics efficiency and advances sustainable urban development.

The financial feasibility analysis highlights the importance of PPPs in addressing funding limitations. Among 42 simulated scenarios, the IC + O&M Cost + Revenue Sharing model stands out by balancing public and private responsibilities in Scenario 39. The final PPP scheme, refined from Scenario 39, allocates costs and revenues across project zones based on stakeholder roles, achieving an IRR of 15.86 %, an NPV of USD 880.7 million, and a PB of 10 years. These outcomes exceed the baseline IRR of 11.99 % obtained without PPP involvement. The structured cost-sharing model enables strategic public–private collaboration. It lowers fiscal pressure on the government and maintains regulatory control. This approach remains highly relevant in emerging markets, where limited public budgets and rising infrastructure demands call for alternative financing solutions.

The structured cost-sharing model supports strategic public–private collaboration, reduces fiscal pressure on the government, and maintains regulatory control. This approach is particularly relevant in emerging economies that face limited public funding, where limited public funds and increasing infrastructure needs require innovative financing solutions.

The Radin Inten Logistic Aerocity contributes to the knowledge base on airport city development by offering an integrated design-financing framework. The process combines technical design and cost-revenue simulations to build a feasible and scalable model for infrastructure in emerging countries. Though the results align with best practices identified in the literature, the study does not cover detailed technical analyses, such as demand forecasting, environmental capacity, and

Table 7
Comparison of each scheme.

Scenario	Private’s IC Contribution	Private’s O&M Contribution	Private’s Revenue Retention	Government Control	Private Sector Risk
IC Sharing	Shared	Private	Private	Low	Moderate to Low
O&M Cost Sharing	Private	Shared	Private	Moderate to Low	High
IC + O&M Cost Sharing	Shared	Shared	Private	Moderate to High	Low
IC + O&M Cost + Revenue Sharing	Shared	Shared	Shared	High	Moderate to Low

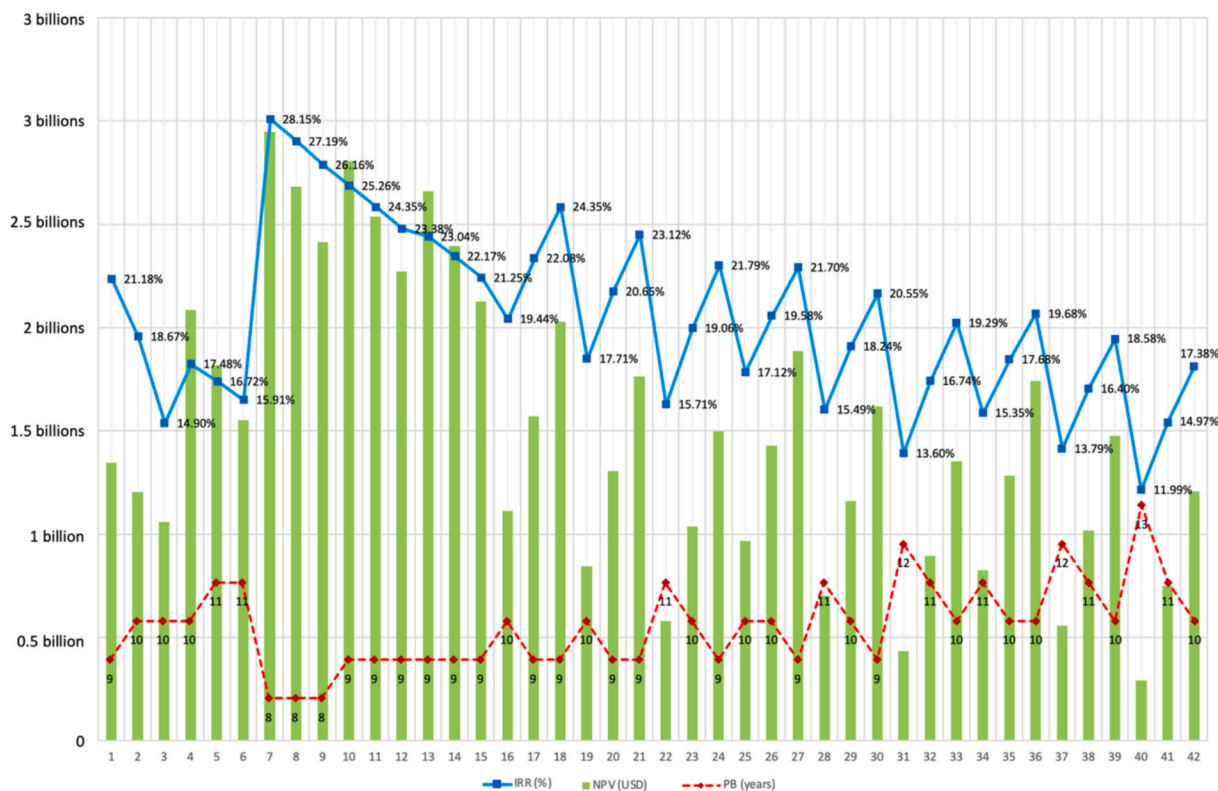


Fig. 15. IRR, NPV, and Payback of the 42 Scenarios.

Table 8
Division of responsibility between the public and private sectors.

Zone	Component	Responsibility
1. Airport	Air Cargo Terminal	Public
2. Integrated Logistic Hub	Intermodal Freight Hub	Private
	Warehouse Complex	Private
	Wholesale Market	Private
3. Industrial Park	Consolidation & Distribution Area	Public
	Pharmaceutical Manufacturing	Private
	Incubator/Discovery Park	Private
4. Commercial Area	MRO	Public
	Mall and Retail Outlet	Private
	Office Park	Private
5. Urban Open Space	Expo Center	Private
	Restaurant, Plaza, and Pond	Public
	Golf Course	Private
	Road network infrastructure	Public

Table 9
Share of costs and revenue between the public and private sector.

Financial Component	Net Present Value (NPV)		Share (%)	
	Private (USD)	Government (USD)	Private	Government
IC	-1,054,461,939	-693,450,805	60.33 %	39.67 %
O&M Cost	-10,326,960,652	-4,172,425,399	71.22 %	28.78 %
Revenue	19,133,447,650	5,493,908,494	77.61 %	22.39 %

comprehensive risk assessments. Future research should explore these aspects and pilot the financing model in other contexts to evaluate its practicality and adaptability for broader application.

CRedit authorship contribution statement

Mustika Sari: Writing – review & editing, Supervision. **Fitria**

Setyawati: Writing – original draft, Software, Methodology, Investigation. **Mohammed Ali Berawi:** Conceptualization. **Perdana Miraj:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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