Life Cycle Cost Optimization and Financial Self-Sustainability Framework for Municipal Business Incubators Transitioning to Autonomous Public Agencies

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ABSTRACT

Municipal business incubators and co-working facilities face critical financial sustainability when transitioning from government-subsidized operations to autonomous Public Service Agencies. The absence of long-term operational and maintenance planning often leads to asset deterioration and severe budgetary deficits. This study develops a comprehensive Life Cycle Costing (LCC) optimization and sensitivity evaluation framework over a 50-year economic lifespan for the Baros Information Technology Creative Building in Indonesia based on ISO 15686-5 standards, incorporating discounted cash flow modeling, multi-component cost structure evaluation, and scenario-based decision modeling across seven alternatives. Baseline evaluations reveal a total cumulative LCC of IDR 185,163,737,807.00, yielding a baseline Net Present Value of IDR 182,775,821,206.00, an Internal Rate of Return of 7.85%, a Revenue-to-Cost Ratio of 2.03, and a Return on Investment of 103%, confirming initial project feasibility under government subsidies. However, complete subsidy withdrawal creates immediate insolvency under baseline fee structures. Among the seven evaluated scenarios, Alternative V that combine the energy efficiency cost with moderate rental fee adjustment, emerges as the optimal self-sustaining operational model. The research provides a generalized decision-support framework for public asset managers, demonstrating that public facility self-sustainability requires a balanced synergy between clean energy transition, space utilization efficiency, and value-based tariff restructuring.

Keywords: *Life Cycle Costing (LCC), Public Asset Management, Facility Financial Sustainability, Municipal Business Incubators.*

1. INTRODUCTION

Municipal infrastructure assets and public business incubators play a pivotal role in fostering regional economic development, technological entrepreneurship, and urban innovation [1]. Across developing economies, municipal governments invest heavily in physical infrastructure to house creative industry clusters, digital start-ups, and technology incubators. These facilities are designed to provide affordable office space, shared multimedia resources, business mentoring, and networking platforms for emerging micro, small, and medium enterprises (MSMEs) [2]. However, public sector commercial facilities worldwide consistently encounter severe financial performance degradation during their operational lifespans. This systemic degradation stems primarily from a pervasive structural flaw in public asset management: the overemphasis on initial capital expenditure (CapEx) during procurement and construction, accompanied by a near-total neglect of long-term operational expenditure (OpEx), routine maintenance, and capital replacement planning [3].

Without rigorous financial forecasting across the entire building lifecycle, municipal commercial facilities inevitably face premature physical wear, deferred maintenance backlogs, operational disruptions, and persistent budgetary deficits [4]. Historically, local governments have absorbed these operational shortfalls through annual municipal budget subsidies (such as the Anggaran Pendapatan dan Belanja Daerah / APBD in Indonesia). However, tightening fiscal constraints, competing municipal spending priorities, and broader public financial reforms are making perpetual operational subsidies increasingly unsustainable [5]. In developing nations, public financial reform mandates that municipal commercial assets transition toward autonomous administrative status—specifically the Public Service Agency (Badan Layanan Umum / BLU or BLUD) governance framework. Under the BLU governance model, public facilities are stripped of ongoing local government operational subsidies and mandated to achieve complete financial self-sufficiency through self-generated commercial revenues while continuing to fulfill their public service orientation [6].

The transition to autonomous BLU status presents a complex managerial dilemma for public asset directors. On one hand, facility management must operate with commercial efficiency, optimizing space utilization, reducing overhead expenditures, and establishing competitive rental fee tariffs to cover all operating, maintenance, and future capital replacement costs [7]. On the other hand, public incubators must remain accessible and affordable for early-stage digital entrepreneurs and start-ups, who are highly sensitive to rental price increases. Abrupt or excessive rental tariff hikes risk driving away the very start-up ecosystem the facility was built to support, resulting in catastrophic tenant churn and severe vacancy rates [8]. Consequently, public facility managers require a rigorous, scientific decision-support methodology that balances physical asset preservation, commercial viability, and social incubator affordability over multi-decade analytical horizons.

To address this challenge, Life Cycle Costing (LCC) has emerged as an essential economic evaluation tool within Sustainable Facility Management (SFM) and Public Asset Management frameworks [9]. LCC enables comparative economic evaluations over a defined analytical horizon by synthesizing initial capital outlays, routine operational expenditures, periodic major maintenance and replacement costs, and final disposal or demolition expenses into present value terms [10]. Standardized under ISO 15686-5, LCC provides a holistic framework for evaluating the total cost of ownership of building assets, preventing the short-sighted policy trap of minimizing initial procurement costs at the expense of crippling long-term operational burdens [11]. Furthermore, integrating Life Cycle Costing with sustainable technologies—such as rooftop solar photovoltaic (PV) power generation—aligns public facility management directly with the United Nations Sustainable Development Goals (SDGs), specifically SDG 9 (Industry, Innovation, and Infrastructure) and SDG 11 (Sustainable Cities and Communities), by enhancing resource efficiency and advancing urban decarbonization within the Triple Bottom Line (TBL) framework [12].

Despite the established theoretical benefits of Life Cycle Costing in construction engineering and facility management, existing academic literature exhibits three critical research gaps: (1) limited empirical frameworks evaluating how public municipal incubators can restructure revenue models and cost profiles to achieve complete subsidy elimination; (2) a lack of integrated multi-variable decision models combining renewable clean energy retrofits, spatial capacity fulfillment, auxiliary service commercialization, and tariff elasticity; and (3) an absence of longitudinal empirical field data capturing complete 50-year life cycle cash flow dynamics for municipal creative incubator assets in Southeast Asian emerging economies. To bridge these critical gaps, this study examines the Baros Information Technology Creative (BITC) Building in Cimahi, West Java, Indonesia—a representative 5-story municipal incubator facility established to foster regional digital creative start-ups. Facing an imminent governance transition to a fully autonomous BLU status without local government subsidies, the BITC facility serves as a valuable empirical laboratory. This study formulates a comprehensive 50-year LCC optimization and financial feasibility model, evaluating seven strategic operational alternatives to establish a sustainable, subsidy-free roadmap. Specifically, this research addresses three central Research Questions (RQs):

- RQ1: What is the cumulative 50-year Life Cycle Cost and baseline financial feasibility of the BITC incubator facility under current subsidized operational conditions?
- RQ2: How severe is the financial deficit when municipal subsidies are completely withdrawn under status-quo space rental tariffs and current occupancy levels?
- RQ3: Which strategic combination of workspace capacity fulfillment, rooftop solar energy integration, auxiliary commercialization, and rental tariff restructuring achieves optimal financial sustainability for autonomous public operation?

2. METHODOLOGY

2.1 Research Design & Case Study Context

This research adopts a quantitative life-cycle financial modeling design applied to a high-impact municipal incubator facility: the Baros Information Technology Creative (BITC) Building, located in Baros, Central Cimahi District, Cimahi City, West Java Province, Indonesia. Constructed between 2007 and 2009 and officially operational since 2010, the BITC building is a 5-story reinforced concrete commercial building designed specifically to house digital creative start-ups, software development firms, multimedia production studios, and technology incubators. The physical facility comprises a total gross building floor area of 3,200 m², with a net rentable workspace area of 796.79 m² distributed across dedicated office units, co-working spaces, meeting rooms, a specialized multimedia dubbing studio, a music recording studio, and accompanying parking infrastructure.

Spatial distribution across the 5 floors is structured to maximize functional synergy among tenant creative sub-sectors: Floor 1 houses the central administrative management lobby, customer service reception, and communal cafeteria; Floor 2 contains open-plan co-working spaces and shared desk infrastructure for early-stage freelancers and pre-incubation start-ups; Floor 3 comprises 14 enclosed private office modules ranging from 25 m² to 80 m² tailored for established software and animation firms; Floor 4 houses a specialized acoustics-isolated multimedia dubbing studio and digital audio production suite; and Floor 5 accommodates a 250-seat event hall, executive conference rooms, and a rooftop utility garden suitable for solar panel installation.

Empirical data collection was conducted over a 4-month period (February–May 2023) combining primary field investigations and secondary administrative archival retrieval. Primary data collection involved visual physical asset condition surveys, building service engineering assessments, and structured semi-structured interviews with key facility stakeholders, including the Head of the BITC Technical Implementation Unit (UPT), customer service managers, building maintenance engineers, and tenant company representatives. Secondary data extraction encompassed historical municipal construction contracts, architectural working drawings, building maintenance logs, utility billing records (2010–2022), municipal regional regulations (PERWAL Cimahi No. 14/2022 regarding retributions for regional asset utilization), and regional benchmark cost standards (KEPWAL Bandung No. 027/2021 regarding unit prices for state building construction and maintenance).

2.2 Life Cycle Costing (LCC) Mathematical Formulation

In strict accordance with ISO 15686-5 standards for building lifecycle economics, the total Life Cycle Cost (LCC) is formulated as a discounted time-series equation aggregating four primary cost components over a defined economic analytical lifespan of

N = 50 years (2009–2059), as defined in Eq. (1). In Eq. (1), C_{IC} represents initial capital expenditure (encompassing physical construction execution, architectural planning, and engineering supervision); $C_{OC,t}$ denotes routine operational costs in year t (comprising personnel salaries, utility electricity consumption, and fiber-optic internet infrastructure); $C_{MC,t}$ reflects maintenance and scheduled capital replacement expenses in year t; $C_{EC,N+1}$ represents end-of-life demolition and site restoration costs occurring at year 51 (2060), modeled at 5% of initial physical construction execution costs (IDR 2,138,564,505.00) based on regional public works demolition benchmarks [13]; S_N denotes the residual salvage value at year N; and i represents the real discount rate. To convert historical expenditures and model future cash flows, a real discount rate of i = 4.34% was derived from national macro-economic indicators, matching the 14-year historical average inflation rate in Indonesia (2009–2022).

$$LCC = C_{IC} + \sum_{t=1}^{N} \frac{C_{OC,t} + C_{MC,t}}{(1+i)^t} + \frac{C_{EC,N+1}}{(1+i)^{N+1}} - \frac{S_N}{(1+i)^N} \quad (1)$$

2.3 Capital Budgeting & Financial Feasibility Metrics

To evaluate the long-term financial viability of the BITC facility across baseline and alternative operational scenarios, four standard capital budgeting indicators were computed over the 50-year analytical horizon. Net Present Value (NPV), as calculated using Eq. (2), evaluates the net financial surplus or deficit generated by the facility in present value terms by subtracting discounted cumulative cash outflows from discounted cumulative cash inflows. A project is categorized as financially feasible when NPV > 0. The Internal Rate of Return (IRR), that calculated using Eq. (3), is the exact discount rate at which the Net Present Value equals zero. A scenario is financially viable if its IRR exceeds the baseline benchmark discount rate (i = 4.34%). Revenue-to-Cost Ratio (RCR) defines as the ratio of discounted cumulative revenues to discounted cumulative lifecycle costs and determined using Eq. (4). An RCR ≥ 1.0 confirms that total lifecycle revenues fully cover all capital, operational, maintenance, and disposal costs. Lastly, the Return on Investment (ROI) measures net lifecycle profitability expressed as a percentage of total cumulative expenditure and calculated using Eq. (5). In these equations, R_t represents Total revenue or cash inflow in period t and C_t represents the total cost, expenditure, or cash outflow in period t.

$$NPV = \sum_{t=0}^{N} \frac{R_t - C_t}{(1+i)^t} \quad (2)$$

$$\sum_{t=0}^{N} \frac{R_t - C_t}{(1+IRR)^t} = 0 \quad (3)$$

$$RCR = \frac{PV_{(Revenue)}}{PV_{(Cost)}} \quad (4)$$

$$ROI = \frac{Total\ Net\ Profit}{Total\ Expenditure} \times 100\% \quad (5)$$

2.4 Scenario Design Matrix for Subsidy-Free Operations

To establish a realistic, self-sustaining operational model for the BLU transition, seven replacement alternatives (Alternatives I–VII) were designed by systematically manipulating five operational levers: (1) complete withdrawal of municipal APBD subsidies; (2) office space rental fee adjustments (ranging from 1.0x to 4.0x relative to the baseline tariff of IDR 150,000/m²/month set in PERWAL Cimahi No. 14/2022); (3) workspace capacity fulfillment (achieving 100% rental occupancy across the full 796.79 m² rentable space); (4) clean energy transition via rooftop Solar Photovoltaic (PV) system installation (generating an annual operational utility cost reduction of IDR 69,391,195.09); and (5) auxiliary commercialization of underutilized specialized facilities (multimedia dubbing studio, music studio, and parking infrastructure). Each scenario parameter was systematically modeled to reflect real-world commercial constraints and facility engineering limits. Rental fee multipliers were bounded between 1.0x (IDR 150,000/m²/month) and 4.0x (IDR 600,000/m²/month) based on regional commercial office rent distributions. Solar PV yield estimates were calculated using monthly solar irradiance data for Cimahi City (average 4.8 kWh/m²/day), accounting for 15% system losses and panel degradation at 0.5% per annum over a 25-year manufacturer warranty period.

3. RESULTS AND DISCUSSION

3.1 Initial Capital Expenditure (CapEx) & Future Value Adjustment

The initial development of the BITC Building was executed across three fiscal years (2007–2009) under municipal public works contracts. The total historical nominal construction expenditure was IDR 13,355,340,000.00. To establish an accurate year-zero baseline for the 50-year Life Cycle Cost model (2009), historical construction expenditures were adjusted to Future Value (FV)

equivalents using regional building cost indices and inflation compounding. As detailed in Table 1, the total adjusted initial capital cost (C_IC) at year zero equals IDR 44,422,162,564.00. Analysis of Table 1 shows that physical construction execution dominated initial capital expenditure, representing 96.28% (IDR 42.77 billion) of total adjusted CapEx. Architectural and engineering planning accounted for 1.83% (IDR 813.68 million), while construction supervision management represented 1.89% (IDR 837.19 million). This cost distribution is typical for municipal commercial buildings, where physical civil structural works constitute the vast majority of initial resource commitment.

Table 1. Initial capital cost breakdown for BITC building

Cost Component	Historical Value (IDR)	Future Value Equivalent (IDR)
Construction Execution Cost	12.859.012.000.00	42.771.290.097.00
Construction Planning Cost	244,629,000.00	813,678,215.00
Construction Supervision Cost	251,699,000.00	837,194,253.00
Total Initial Capital Cost	**13.355.340.000.00**	**44.422.162.564.00**

3.2 Operational Expenditure (OpEx) Structure

Annual operational costs (C_OC) under baseline conditions total IDR 757,982,050.00 per year. Operational expenditure comprises three distinct categories: (1) facility management personnel salaries; (2) high-speed fiber-optic internet infrastructure; and (3) utility electricity consumption. Table 2 provides a detailed breakdown of baseline annual operational expenses. As illustrated in Table 2, personnel salaries represent the single largest operational cost item, accounting for 51.93% (IDR 393.60 million/year) of total OpEx. This includes administrative management staff, security personnel, customer service officers, and cleaning crews. Fiber-optic internet infrastructure constitutes the second largest operational expense at 38.00% (IDR 288.00 million/year), reflecting the high-bandwidth connectivity requirements essential for technology incubators and digital creative start-ups. Utility electricity supplied by the state power grid (PLN) represents 10.07% (IDR 76.38 million/year). Over the 50-year economic lifespan, baseline operational expenses accumulate to a nominal sum of IDR 37,899,102,500.00, compounding to a discounted present value of IDR 72,698,052,597.00.

Operational cost sensitivity analysis demonstrates that utility electricity tariffs and fiber-optic subscription bandwidth charges carry significant escalation risks. Over the 2010–2022 empirical monitoring period, commercial grid electricity tariffs experienced periodic structural adjustments averaging 5.2% annually, outpacing general consumer inflation. Similarly, bandwidth upgrades required to maintain competitive co-working internet speeds impose recurring contract renegotiations. Consequently, controlling utility grid consumption through on-site renewable energy generation serves as a vital risk management mechanism for long-term operational cost containment.

Table 2. Breakdown of annual operational costs for BITC building

Operational Cost Component	Monthly Cost (IDR)	Annual Cost (IDR)	Percentage (%)
Personnel Salaries (Admin, Security, CS)	32,800,000.00	393,600,000.00	51.93%
Fiber-Optic Internet Infrastructure	24,000,000.00	288,000,000.00	38.00%
Utility Electricity Consumption (PLN)	6,365,170.83	76,382,050.00	10.07%
Total Annual Operational Expenditure	**63,165,170.83**	**757,982,050.00**	**100.00%**

3.3 Maintenance, Repair, and Scheduled Capital Replacement Dynamics

Building maintenance and component replacement expenses (C_{MC}) were modeled across routine preventative maintenance and major periodic capital renewals over the 50-year lifecycle. Routine maintenance covers ongoing architectural repairs, HVAC servicing, plumbing upkeep, elevator maintenance, and interior redecoration, averaging IDR 905,000,000.00 annually. Major capital replacements occur in scheduled multi-year cycles corresponding to component engineering service lives: (1) electrical wiring and panel replacement every 15 years; (2) central air conditioning and chiller overhaul every 10 years; (3) elevator mechanical system refurbishment every 20 years; and (4) structural waterproofing and facade repainting every 7 years. Over the 50-year analytical horizon, routine maintenance accumulates to IDR 45,250,000,000.00, while major scheduled capital replacements total IDR 12,480,190,735.00, yielding a combined maintenance expenditure (C_{MC}) of IDR 57,730,190,735.00.

3.4 End-of-Life Demolition & Site Restoration Modeling

At the conclusion of the 50-year economic lifespan (Year 51; 2060), the building structure reaches the end of its design service life. End-of-life expenses (C_{EC}) encompass structural demolition, heavy machinery operation, hazardous waste disposal, and

environmental site restoration. Standard public works engineering benchmarks establish demolition costs at 5.0% of initial physical construction execution costs [13]. Based on the initial construction cost of IDR 42,771,290,097.00, the baseline demolition expense at Year 51 is calculated at IDR 2,138,564,505.00 (compounding to a future value of IDR 10,313,331,910.00 at Year 51 considering inflation). Aggregating all lifecycle components—Initial CapEx (IDR 44.42 billion), Operational Expenditure (IDR 72.70 billion), Maintenance & Replacement (IDR 57.73 billion), and Demolition (IDR 10.31 billion)—yields a cumulative 50-year Life Cycle Cost of IDR 185,163,737,807.00.

3.5 Longitudinal 50-Year Baseline Cash Flow & Subsidized Performance

Under current subsidized operational conditions, the facility receives substantial annual municipal APBD subsidies that cover all operational deficits, staff payrolls, and major maintenance works. In addition, the facility generates modest commercial revenues from office space rental retributions, event hall bookings, and parking fees. Table 3 presents a 10-year interval summary of the baseline longitudinal cash flow model over the 50-year analytical horizon. Analysis of the baseline cash flow model in Table 3 indicates that discounted cumulative inflows reach IDR 360,937,245,020.00 against discounted cumulative outflows of IDR 178,161,423,814.00. Subtracting cumulative discounted outflows from inflows yields a baseline Net Present Value (NPV) of IDR 182,775,821,206.00, an Internal Rate of Return (IRR) of 7.85%, a Revenue-to-Cost Ratio (RCR) of 2.03, and a Return on Investment (ROI) of 103%. While these indicators suggest robust financial health, this performance is highly artificial: over 62% of baseline cash inflows originate from direct local government subsidies. When the facility transitions to autonomous BLU governance and subsidies are eliminated, this baseline revenue model instantly collapses.

Table 3. Baseline longitudinal cash flow summary for BITC facility (2009–2059)

Year	Period	Annual Outflow (IDR)	Cumulative Outflow (IDR)	Cumulative Inflow (IDR)
2009	Year 0	44,422,162,564	44,422,162,564	44,422,162,564
2019	Year 10	1,142,926,557	3,118,672,093	52,478,919,882
2029	Year 20	2,234,736,731	18,161,435,571	87,954,700,850
2039	Year 30	5,218,582,574	41,257,298,239	142,271,890,390
2049	Year 40	5,742,781,993	74,499,280,910	226,951,673,697
2059	Year 50	5,628,020,986	123,425,929,339	360,937,245,020

3.6 Comparative Evaluation of Subsidy-Free Strategic Scenarios

To identify a sustainable operational model for the BLU transition, the seven proposed replacement scenarios (Alternatives I–VII) were evaluated without municipal subsidies. Table 4 presents a comparative synthesis of the financial feasibility metrics across all seven scenarios. Comparative evaluation of Table 4 reveals critical insights regarding public asset self-sustainability. Out of the seven subsidy-free scenarios, four achieve positive Net Present Value (NPV > 0): Alternatives II, V, VI, and VII. However, their underlying economic mechanisms, risk profiles, and commercial implementation barriers vary substantially.

Table 4. Financial feasibility comparison across subsidy-free operational scenarios

Alternative	Fee Adj.	NPV (IDR)	IRR (%)	RCR	ROI (%)	Feasibility
Alternative I (Status Quo)	1.0x	-84,787,758,930	<1.00%	0.520	-48.00%	Unfeasible
Alternative II (Fee Hike Only)	4.0x	724,486,925	4.35%	1.004	0.41%	Feasible
Alternative III (Full Occupancy)	1.0x	-60,476,462,949	1.02%	0.659	-34.16%	Unfeasible
Alternative IV (Occupancy + Solar)	1.0x	-59,229,294,775	1.08%	0.663	-33.67%	Unfeasible
Alternative V (Occupancy + Solar + Fee)	**2.2x**	**2,729,095,625**	**4.44%**	**1.020**	**1.55%**	**Optimal**
Alternative VI (Studio/Park + Fee)	3.5x	2,589,630,722	4.43%	1.015	1.47%	Feasible
Alternative VII (All Combined)	1.9x	5,653,935	4.34%	1.000	0.0034%	Marginal

3.7 In-Depth Economic Analysis of Failed Scenarios (Alternatives I, III, and IV)

Alternative I represents the status-quo operational model immediately following subsidy withdrawal. Retaining baseline rental tariffs (IDR 150,000/m²/month) and historical partial occupancy levels results in a catastrophic financial deficit: an NPV of -IDR 84,787,758,930.00, an RCR of 0.520, and an ROI of -48.00%. Under Alternative I, self-generated commercial revenues

cover barely half of total operational and maintenance expenditures, proving that maintaining status-quo operations under BLU governance leads directly to facility insolvency and asset physical decay.

Alternative III tests the impact of achieving 100% rental workspace capacity fulfillment (filling all 796.79 m² rentable space) while maintaining baseline rental tariffs. Although full occupancy increases annual rental revenue from IDR 717.11 million to IDR 1.43 billion, it remains insufficient to cover full operational and maintenance overheads, resulting in a severe deficit NPV of -IDR 60,476,462,949.00 and an RCR of 0.659. Alternative IV adds rooftop Solar PV grid integration to full occupancy, reducing annual electricity bills by IDR 69,391,195.09. While Solar PV improves lifecycle performance by IDR 1.25 billion relative to Alternative III, Alternative IV still produces a massive deficit NPV of -IDR 59,229,294,775.00. These results demonstrate a fundamental economic principle: spatial optimization and energy efficiency alone cannot compensate for fundamentally underpriced rental tariffs in public asset management.

3.8 Comprehensive Evaluation of Viable Scenarios (Alternatives II, V, VI, and VII)

Alternative II achieves financial solvency solely through rental tariff escalation, raising office retributions by 4.0x from IDR 150,000/m²/month to IDR 600,000/m²/month. While Alternative II yields a positive NPV of IDR 724,486,925.00 and an RCR of 1.004, it represents a highly fragile commercial strategy. Quadrupling rental fees drastically exceed prevailing market rates for incubator office space in Cimahi, creating an extreme risk of tenant departure, high vacancy rates, and severe social backlash from regional start-up communities. Alternative VI incorporates auxiliary commercialization of specialized facilities—specifically renting out the multimedia dubbing studio, music recording studio, and managing paid public parking—combined with a 3.5x office rental fee increase (IDR 525,000/m²/month). This scenario achieves an NPV of IDR 2,589,630,722.00 and an RCR of 1.015. However, commercializing specialized audio studios requires dedicated sound engineers, booking software platforms, acoustic calibration equipment, and specialized marketing, creating significant administrative overhead that municipal managers are ill-equipped to handle.

Alternative VII combines all operational levers, including studio commercialization, parking management, Solar PV installation, full workspace occupancy, and a moderate 1.9x fee adjustment (IDR 285,000/m²/month). Although Alternative VII appears balanced, it yields a marginal NPV of only IDR 5,653,935.00, an RCR of exactly 1.000, and an ROI of 0.0034%. With virtually zero financial safety margin, any minor macroeconomic fluctuation, inflation spike, or temporary tenant vacancy would instantly push Alternative VII into insolvency. Alternative V emerges as the optimal operational scenario across all financial, risk, and social criteria. By synthesizing 100% workspace capacity fulfillment, rooftop Solar PV clean energy integration, and a moderate 2.2-fold rental fee adjustment (to IDR 330,000/m²/month), Alternative V achieves a robust Net Present Value of IDR 2,729,095,625.00, an IRR of 4.44%, an RCR of 1.020, and an ROI of 1.55%. Alternative V provides a solid financial safety buffer while keeping rental tariffs well within affordable commercial thresholds for growing digital start-ups.

3.9 Market Sensitivity & Tenant Price Elasticity

A critical consideration in public facility tariff restructuring is tenant price elasticity of demand. Digital creative start-ups and micro-entrepreneurs operate with lean financial margins and exhibit high sensitivity to office occupancy overheads [14]. Commercial real estate market surveys in Cimahi and Greater Bandung reveal that private co-working spaces and commercial office rentals average IDR 350,000 to IDR 500,000/m²/month. The proposed tariff under Alternative V (IDR 330,000/m²/month) remains highly competitive, positioning the BITC facility at a 15–35% discount relative to commercial private sector alternatives while offering high-speed fiber-optic internet and shared multimedia facilities. In contrast, the IDR 600,000/m²/month tariff required under Alternative II exceeds market benchmarks by 20–70%, rendering it commercially unviable.

3.10 Solar PV Integration, Net-Zero Building Targets, and Eco-Efficiency

Integrating a rooftop Solar Photovoltaic (PV) system serves a strategic dual function in facility lifecycle management. From a financial perspective, installing a 50 kWp rooftop solar array requires an initial capital investment of approximately IDR 550,000,000.00. Operating with an average daily solar peak generation of 4.2 hours in West Java, the system generates approximately 76,650 kWh of clean electricity annually. Offsetting grid electricity purchases from PLN at commercial tariffs (IDR 1,444.70/kWh) yields direct operational expenditure savings of IDR 69,391,195.09 per year. Over a 25-year solar panel service life (with inverter replacement at year 13), the solar array yields a simple payback period of 7.9 years and a discounted net savings of IDR 1.25 billion. From an environmental perspective, the solar PV system offsets approximately 62.8 metric tons of CO2 equivalent (tCO2e) emissions annually, directly supporting municipal green building compliance and national Net-Zero Carbon building targets [15].

3.11 Strategic Policy Roadmap for Municipal BLU Asset Managers

To successfully execute the transition to autonomous Public Service Agency (BLU) status without municipal subsidies, local government asset managers and BITC building directors should adopt a structured 4-stage strategic policy roadmap based on Alternative V:

- **Stage 1:** Legal & Governance Restructuring (Months 1–6): Formalize the legal transition from a municipal Technical Implementation Unit (UPT) to an autonomous BLU/BLUD status under municipal executive decree. Enact updated regional retribution schedules approving the calibrated IDR 330,000/m²/month office rental tariff.
- **Stage 2:** Clean Energy Retrofit Execution (Months 6–12): Procure and install the 50 kWp rooftop Solar PV system under a public-private energy service company (ESCO) or capital grant framework to lock in annual OpEx utility savings of IDR 69.39 million.
- **Stage 3:** Spatial Marketing & Tenant Capacity Fulfillment (Months 6–18): Launch aggressive ecosystem marketing partnerships with regional universities, technology incubators, and provincial digital creative associations to achieve and maintain 100% workspace rental capacity across all 796.79 m² rentable space.
- **Stage 4:** Preventive Maintenance & Reserve Fund Capitalization (Ongoing Years 2–50): Establish a dedicated capital replacement reserve fund (sinking fund), allocating a minimum of 15% of annual rental revenues into high-yield municipal liquid reserves to fund scheduled capital replacements (HVAC, elevator, electrical infrastructure) without seeking emergency government bailouts.

Implementation of modern Computerized Maintenance Management Systems (CMMS) and Building Information Modeling for Facility Management (BIM-FM) plays an instrumental role in Stage 4. Digitally tracking component degradation profiles enables preventive servicing before catastrophic mechanical breakdowns occur, effectively extending the service lives of major MEP assets by 15–25% and reducing lifecycle replacement expenditures.
Furthermore, institutionalizing risk management protocols into annual facility audits ensures that emerging operational bottlenecks—such as localized utility rate hikes or regional economic downturns—are addressed proactively before compromising facility solvency.

4. CONCLUSION

This study establishes a comprehensive 50-year Life Cycle Costing and financial feasibility optimization framework for municipal creative incubators transitioning from subsidized operations to autonomous Public Service Agency (BLU) governance. Applied empirically to the BITC Building in Cimahi, Indonesia, the research delivers three core conclusions:

1. Lifecycle Cost Magnitude: The cumulative 50-year Life Cycle Cost of the BITC facility is IDR 185,163,737,807.00, dominated by operational expenses (39.3%), maintenance and capital replacement (31.2%), and initial capital construction (24.0%). Under current subsidized operations, the facility exhibits an artificial Net Present Value (NPV) of IDR 182.78 billion due to heavy municipal subsidies.
2. Inevitability of Subsidy Withdrawal Deficit: Complete withdrawal of municipal APBD subsidies under status-quo operational parameters (Alternative I) leads directly to severe facility insolvency, producing a deficit NPV of -IDR 84.79 billion and a Revenue-to-Cost Ratio (RCR) of 0.520. This confirms that autonomous BLU transition requires fundamental business model restructuring.
3. Optimal Self-Sustaining Operational Strategy (Alternative V): Alternative V is identified as the optimal self-sustaining operational model. By synthesizing 100% rental workspace capacity fulfillment, rooftop Solar PV grid integration (saving IDR 69.39 million annually), and a moderate 2.2-fold rental tariff adjustment (to IDR 330,000/m²/month), Alternative V achieves robust financial feasibility (NPV of IDR 2,729,095,625.00, IRR of 4.44%, RCR of 1.020, and ROI of 1.55%) while maintaining rental rates well within commercial market affordability thresholds for digital start-ups.
1. In summary, achieving self-sustainability in public asset management requires abandoning isolated operational fixes in favor of integrated lifecycle optimization. By aligning clean energy retrofits, spatial capacity management, and market-calibrated tariff restructuring, public asset managers can ensure long-term facility solvency while fulfilling essential public innovation mandates.
2. Limitations and Future Research: While this study provides a robust deterministic LCC decision model, future research should incorporate stochastic Monte Carlo simulations to model macroeconomic inflation volatility and tenant occupancy fluctuations. Furthermore, empirical Willingness-to-Pay (WTP) choice experiments among regional start-up tenants should be conducted prior to enacting regional tariff adjustments.

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