Eduvest – Journal of Universal Studies
Volume 6 Number 6, June, 2026
p- ISSN 2775-3735- e-ISSN 2775-3727

Feasibility Analysis of a Precast Concrete Business in the Remote Areas of Tanjung Sauh Island Using the Tlmbc Approach

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Keywords
precast concrete; sez; tlbmc; sustainability; logistics efficiency.

Abstract
This study examines the business feasibility of establishing a precast concrete plant in Tanjung Sauh Special Economic Zone (SEZ), Batam, using the Triple Layered Business Model Canvas (TLBMC) framework. Tanjung Sauh SEZ is projected to attract IDR 199.6 trillion in investment and create over 360,000 jobs by 2053, yet faces a structural challenge of no land access to Batam, resulting in material cost increases of 20 to 30 percent and delivery delays of two to three weeks per cycle. This study employed a descriptive qualitative approach with a prospective single case study design, collecting data through field observation, semi-structured interviews with eight purposively selected informants, and document analysis, validated through source, method, and data triangulation. Findings confirm multidimensional feasibility: economically through an IRR of 24 percent, four-year payback period, positive NPV, and 25 percent cost efficiency reinforced by KEK fiscal incentives; environmentally through 25 to 30 percent transport CO_2 emission reduction, fly ash substitution, and circular economy principles; and socially through a minimum 70 percent local workforce commitment, comprehensive occupational safety management, and ESG governance. The three layers form a self-reinforcing causal chain, making this business model systemically sustainable.

INTRODUCTION

The SIJORI (Singapore–Johor–Riau) region is one of the most dynamic growth triangles in Southeast Asia, combining Singapore's capital and technological advantages with the land resources and labor of the Riau Islands. In the November 2025 BBK forum initiated by the Singapore Economic Development Board (EDB) and the Coordinating Ministry for Economic Affairs, the government affirmed its commitment to strengthen the Batam–Bintan–Karimun area as a sustainable investment destination (Coordinating Ministry for Economic Affairs, 2025).

The government has designated Tanjung Sauh Island as a Special Economic Zone (SEZ) through Government Regulation No. 24 of 2024, with a total investment plan of IDR 199.6 trillion and a projected labor absorption of more than 360,000 people until 2053 (National Council of SEZs, 2024). PT Batamraya Sukses Perkasa (BSP), a subsidiary of Panbil Group appointed as the Tanjung Sauh SEZ BUPP, is responsible for developing an area of 840.67 hectares including a port, independent power plant, and a road network with international green industry standards. PT Harapan Jaya Sentosa (HJS), another subsidiary of Panbil Group, has relevant capacity in the form of 39 years of experience in the construction of industrial estates, existing batching plants, and available land in Tanjung Sauh (Pakiam et al., 2020).

The main phenomenon gap that is the focus of this research is the absence of precast concrete production facilities in the area, while the need for materials grows in a structured manner (Martins et al., 2023; Wang et al., 2020; Yang & Zhou, 2026). The absence of land access to Batam causes all construction materials to have to be imported by sea, resulting in a 20–30% increase in material prices and an additional delivery time of 2–3 weeks per cycle which are the two main risks of cost overrun and schedule delays in remote areas (Anggoro et al., 2025). This condition is fundamentally different from urban contexts where precast studies are generally conducted (Parameswaran et al., 2025).

The decision to establish a precast plant goes beyond mere economic calculations because it affects carbon emission patterns, local employment structures, and the distribution of benefits to the surrounding area (Joyce & Paquin, 2016). Unlike conventional BMCs that only capture economic value, TLBMC is able to describe the business model as a whole in three layers: economic, environmental, and social, with horizontal coherence (inter-blocks in one layer) and vertical coherence (inter-layers) that reinforce each other. The formulation of the research problem is the lack of a feasibility analysis that integrates all three dimensions simultaneously for the establishment of a precast concrete plant in the context of remote island SEZs.

The research question asked is "Is the establishment of a precast concrete plant by PT Harapan Jaya Sentosa in the Tanjung Sauh SEZ feasible multidimensionally from an economic, environmental, and social perspective based on the Triple Layered Business Model Canvas (TLBMC) framework?"

The Triple Layered Business Model Canvas (TLBMC) was introduced by Joyce and Paquin (2016) as a development of the classic Business Model Canvas (BMC) that focuses solely on economic value creation. Through the addition of environmental and social layers, TLBMC becomes a comprehensive analytical instrument for designing and validating sustainability-oriented business models. Within this framework, a business model is judged not only on its financial profitability, but also on the basis of its ecological impact and the social contribution generated simultaneously.

The main advantages of TLBMC lie in two dimensions of integration: horizontal coherence that describes the relationships between blocks in a single layer, and vertical coherence that describes the interconnectedness between economic, environmental, and social layers. This integration allows researchers and practitioners to comprehensively understand the systemic linkages between business activities, environmental impacts, and generated social value (Joyce & Paquin, 2016). Midgley and Arya (2022) emphasized that TLBMC is effectively used as a tool for visualizing, creating, and validating sustainable business models, especially in the context of industries that have significant environmental and social impacts.

Various recent studies have applied TLBMC in various sectors. Mili and Loukil (2023) applied TLBMC to the fruit and vegetable industry in Spain and found that the integration of the three layers resulted in a deeper understanding of the trade-offs between economic efficiency and environmental impact. Amalia Fadila et al. (2024) used it for the development of sustainable business models for MSMEs in Indonesia and found that the social layer is the most influential differentiating element in building the loyalty of local stakeholders. In the context of the construction industry, Saad et al. (2023) examined Modern Methods of Construction in the UK public sector and found that a deep understanding of the target customer is the most significant element in successful market penetration. Bachmann et al. (2025) propose an 18-element framework that includes ecosystems, co-creation, and sustainable capabilities as new elements relevant to the modern industrial era.

The economic layer in TLBMC focuses on the creation of financial value and operational efficiency with NPV, IRR, and ROI indicators as standard criteria for financial viability. Parameswaran et al. (2025) found that the efficiency of the production process and the

reduction of waste directly impact the improvement of profit margins. Anggoro et al. (2025) identified 18 high-priority risks at the Probowangi precast plant in East Java using the Probability Impact Matrix based on ISO 31000:2018. The economic dimension in this study is also strengthened by a cost of risk analysis that includes the risk of supply delays due to dependence on shipments from mainland Batam which is vulnerable to north wind disturbances, as well as the risk of schedule delays that have an impact on the postponement of regional operationalization. Precast production within the region structurally eliminates these two risks while making HJS a strategic position for consumers.

The environmental layer assesses business impact through a Life-Cycle Assessment approach that covers the entire value chain from raw material extraction to recycling. UNEP (2022) reported that the construction sector accounts for 37 percent of total global CO_2 emissions. Xu et al. (2023) found that the carbon emissions of precast concrete slabs of 43.31 $kgCO_2e/m^2$ were lower than those of on-site cast slabs of 46.32 $kgCO_2e/m^2$, with the material production stage accounting for 97.45 percent of the total emissions, so fly ash substitution had a very significant impact. In the context of the Tanjung Sauh SEZ, on-site precast production is projected to reduce CO_2 emissions from sea transportation by 25 to 30 percent compared to procurement from mainland Batam while reducing logistics costs which are the main barriers to investment.

The social layer assesses how business activities create social value for all stakeholders. Ferdousi and Abedin (2023) show that local recruitment integrated into the company's core strategy contributes significantly to the creation of shared value. Akanpaadgi (2023) affirms that authentic CSR programs build mutually beneficial social relationships between companies and local communities. In the context of the Tanjung Sauh SEZ, the establishment of a precast plant has the potential to create sustainable formal employment and reduce dependence on seasonal construction work.

The three layers are vertically connected so decisions on one layer always have implications for the other layers (Joyce & Paquin, 2016, Bachmann et al., 2025). The application of TLBMC to HJS in the Tanjung Sauh SEZ is different from similar companies in non-SEZ areas because of three uniqueness: SEZ incentives in the form of VAT exemption and tax holidays that substantively change the structure of the economic layer; the condition of the archipelago creates a direct correlation between production site decisions and environmental impacts because the elimination of one barge trip from Batam means the elimination of measurable transportation emissions; and captive market status protects local workers from seasonal work cycles so that social impacts are structural and long-term. The benchmark for the Probowangi plant (Anggoro et al., 2025) confirms that TLBMC for HJS is not just an adaptation of a generic model, but a framework that is specifically tailored to the unique context of the region.

The novelty of this study is fourfold. First, it applies TLBMC to a heavy industrial context (precast concrete) in a remote island SEZ, extending the framework beyond its typical MSME and urban applications. Second, it integrates three dimensions of feasibility economic, environmental, and social simultaneously within a single case study, responding to calls for more holistic sustainability assessments in construction logistics (Bachmann et al., 2025). Third, it uses triangulation of sources (eight informants from three organizational levels), methods (observation, interviews, document analysis), and data (primary and secondary) to validate each of the 27 TLBMC blocks, ensuring methodological rigor uncommon in business feasibility studies. Fourth, it identifies and analyzes vertical coherence the causal chains linking economic efficiency (25 percent cost savings) to environmental benefits (25-30 percent emission reduction) to social value (70 percent local recruitment) demonstrating systemic sustainability rather than partial optimization.

The objective of this research is to analyze the multidimensional feasibility of establishing a precast concrete plant by PT Harapan Jaya Sentosa in the Tanjung Sauh SEZ from economic, environmental, and social perspectives using the TLBMC framework. The research contribution is twofold: theoretically, it enriches the TLBMC literature by applying the framework to a novel context (remote island SEZ heavy industry) and empirically demonstrating vertical coherence; practically, it provides PT HJS and Panbil Group with evidence-based recommendations for plant establishment, operational planning, and ESG governance. The benefits include validated financial projections (24 percent IRR, four-year payback), quantified environmental impact reductions, and a measurable social commitment framework (70 percent local recruitment, SMK3, ESG KPIs).

METHOD

This study used a descriptive qualitative approach with a prospective single case study design (Yin, 2018) based on three epistemological arguments. Ontologically, multidimensional feasibility is a socio-economic reality that can only be understood through triangulation of stakeholder perspectives, not numerical questionnaires. Epistemologically, the TLBMC instrument results in a mapping of business model blocks, not regression coefficients. Axiologically, the strategic recommendations for HJS and Panbil Group require a narrative context that cannot be replaced by numbers alone. Prospective case studies were chosen because the truth sought is not financial projections but rather confirmation that each TLBMC block has a valid phenomenological basis from verified real conditions. The research framework answers the where and who, namely the Tanjung Sauh SEZ with PT HJS and BUPP BSP, as well as the why and how that the condition of the remote islands creates a direct correlation between production locations and economic efficiency, environmental emissions, and local labor absorption. The collection of data on answering when, was carried out from September 2025 to January 2026 through three complementary methods. Field observations use a six-aspect guide that is explicitly linked to the TLBMC block. The semi-structured interview was carried out in nine sessions with eight purposive informants, namely AR as the Director of Operations of BSP as a decision-maker from the customer side, SL as the President Director of BUPP and WA as the HR Manager of BUPP as a monitor of tenant activities against the estate regulation of the area, WT as the Accounting Manager and AM as the Director of HJS Project as the company's internal implementer, and TT as the BUPP Environmental Manager with 16 years of experience in management EIA and approval of RKL-RPL Details of all area tenants. The document analysis includes Government Regulation No. 24 of 2024, the SEZ master plan, HJS internal financial documents, the Detailed RKL-RPL Addendum, the Minister of Environment and Forestry Regulation No. 5 of 2014, and SNI 03-6866. The combination of the three methods forms a triangulation base of sources, methods, and data that ensures each TLBMC block is verified, mapped to 27 blocks, and synthesized through a 3P framework as an interlocking causality chain.

Table 1 Informant Data

Coating	Informants	Code	Company	Position	Information
Economy	Mr. Anwar Rajaguguk	AR	PT. Batamraya Is A Mighty Success	Director of Operations	Customer Segment Customer Relationship Channel Value Proposition
Economy	Mr. Sarifuddin Lumbantoruan	SL	BUPP SEZ Tanjung Sauh	President Director	Partners
Economy	Mr. Ahmad Mustafid	AM	PT. Hope Jaya Sentosa	Project Director	Value Proposition Activities Resources

Coating	Informants	Code	Company	Position	Information
Economy	Mr. Widijaya Tan	WT	PT. Hope Jaya Sentosa	Accounting Manager	Revenue Cost
Environment	Mr. Teddy Tambunan	ID	BUPP SEZ Tanjung Sauh	Environmental Manager	End of life Enviromental Benefits Environmental Impacts
Environment	Mr. Ahmad Mustafid	AM	PT. Hope Jaya Sentosa	Project Director	User Phase Distribution Functional Value Production Materials Supplies and Outsourcing
Environment	Mr. Sarifuddin Lumbantoruan	SL	BUPP SEZ Tanjung Sauh	President Director	Environmental Impacts
Social	Mrs. Widiastuti	WA	BUPP SEZ Tanjung Sauh	HR Manager	Social Culture Scale of Outreach Social Value Social Benefits Social Impacts
Social	Mr. Ahmad Mustafid	AM	PT. Hope Jaya Sentosa	Project Director	End user Scale of outreach Social Culture Social Value Governence Employees Local community

Triangulation is applied as a thorough validation method through three forms applied simultaneously. Source triangulation confirms each phenomenon from at least two different groups of informants, as confirmed by SL as a regulator and WT as an HJS accountant, then verified by Government Regulation No. 24/2024. The triangulation method confirms each interview findings with field observations and verified documents, as the 80 percent regional readiness claim submitted by AR is confirmed through direct observation and BSP progress documents. Data triangulation contextualized the findings with the academic literature, as the AM-confirmed reduction of CO_2 emissions was in line with Xu et al. (2023) on the precast emission profile. Operationally, the researchers compiled a confirmation matrix per TLBMC block containing observational findings, interview citations, verified documents, and literature references, where the convergence of the four columns marked valid and reliable findings.

RESULTS AND DISCUSSION

Economic Layer

Field Observation Results

Field observations identified four concrete economic phenomena that make up the context of HJS's financial viability. First, the readiness of the area reaches 80% by Q4 2025 so that orders for precast concrete materials can start in Q3 2026 as scheduled, which means that real demand has been physically identified in the field. Second, the readiness of the HJS factory area is expected to be completed by the end of Q2 2026, providing sufficient time for equipment installation and testing before the first order comes in. Third, the region's utility system that includes stand-alone SEZ power plants and BUPP water recycling systems has been identified as being ready for operation, which directly reduces long-term operational costs compared to factories outside SEZs that depend on public infrastructure. Fourth and most economically fundamental, the SEZ infrastructure that is being built requires channels of more

than 300 kilometers, not including ports and industrial buildings, so that this volume of demand is physically verified from the observed map of the area.

Interview Results

AR said "The absence of land access to Batam causes all construction materials to have to be imported by sea, which has an impact on increasing material prices by 20 to 30 percent and increasing delivery time of two to three weeks per cycle. This burden is very significant considering that the area requires more than 300 kilometers of channels, not including ports and industrial buildings. In this context, HJS is considered the most appropriate partner because of its more than 30 years of experience in industrial estate construction and the status of SEZ Business Actors that allow direct appointment, while providing added value in the form of operational flexibility and quality transparency that can be verified directly by investors."

The AR statement confirms two of HJS's six key proposition values (elimination of 2–3 weeks delay and quality transparency) from the perspective of the direct customer. This is the most authoritative demand-side confirmation.

SL said "HJS as a SEZ Business Actor is entitled to two fiscal incentives that directly strengthen the financial viability of the business. First, the exemption of Value Added Tax on all transactions in the area so that the operational cost structure becomes more efficient than business actors outside SEZs. Second, tax holidays are in the form of corporate tax exemption for 10 to 20 years with a minimum investment requirement of IDR 100 billion. The combination of these two incentives accelerates the period of return on investment and increases the net value for shareholders, making the status of SEZ Business Actors not just administrative recognition but a real and measurable competitive advantage."

This finding was verified through Government Regulation No. 24/2024 and is in line with Saad et al. (2023) that government policies are the main determinant of the profitability of the construction business.

AM said, "Precast concrete offers three main added values, namely cost efficiency, production speed, and quality assurance. The production process is not constrained by weather conditions so as to avoid delays that are often experienced by the on-site cast method, while the controlled factory environment produces more consistent and standardized concrete quality. The presence of precast manufacturing in Tanjung Sauh directly reduces logistics and installation labor costs so that the cost factor becomes more competitive. Modular production systems with steel molds enable efficiency and consistency of production results, supported by a network of partners that includes reinforcing iron suppliers, barge owners, and heavy equipment suppliers."

AM's statement confirmed that the presence of precast plants within the region directly eliminated the three main obstacles to the construction of the archipelago, namely weather delays, quality inconsistencies, and logistical burdens.

WT said "The revenue potential comes from three main streams, namely the sale of precast concrete products, installation services in the field, and the sale of recycled production waste reinforcing iron, thus providing better cash flow stability compared to businesses with a single source of income. The cost structure is divided into investments that include the construction of buildings, equipment, HR training, and heavy equipment, as well as operational costs which include raw materials, payroll, maintenance, employee accommodation, taxes, and risk reserves. The biggest risk is the disturbance of the north wind which has the potential to hinder the delivery of raw materials, so an adequate stock buffer policy is needed. The business plan is prepared for a 10-year horizon with the results of the financial feasibility calculation showing an IRR of 24 percent, a payback period of four years, and a positive NPV, which is based on the findings of a market study that the procurement of materials from Batam is 25 percent more expensive than production in the region."

The WT statement confirmed HJS's financial feasibility with an IRR of 24 percent, a four-year payback period, and a cost efficiency of 25 percent compared to procurement from Batam.

Analysis

The economic layer of TLBMC PT HJS in the Tanjung Sauh SEZ shows financial feasibility that is strengthened by structural advantages that cannot be replicated by competitors from outside the area. With an IRR of 24 percent, a four-year payback period, and a positive NPV, this business model is supported by three complementary revenue streams as well as SEZ fiscal incentives in the form of VAT exemption and 10 to 20-year tax holidays.

The analysis of the economic layer is focused on the value proposition because several other blocks are already inherently defined. Customer segments, channels, and customer relationships do not require in-depth analysis considering that HJS and BUPP BSP are in the same business group, namely the Panbil Group, so that customer relationships are captive with communication channels and structured transaction mechanisms. Key partners include raw material suppliers, barge owners, and installation contractors. Key activities include production, quality control, and supply chain management. Key resources consist of factory land, modular steel molds, batching plants, and trained human resources.

Value proposition analysis reveals four dimensions of value that work simultaneously and reinforce each other. In terms of get the job done, HJS is present as a single solution to the infrastructure needs of SEZs that cover more than 300 kilometers of channels not including ports and industrial buildings, so that BUPP BSP no longer depends on the unpredictable rhythm of sea shipping from Batam. In terms of risk reduction, the risks eliminated are multi-layered, including schedule risks through the elimination of waiting times of two to three weeks per cycle, quality risks through controlled production in the factory environment, and financial risks through price stability that no longer depends on fluctuations in procurement from Batam. In terms of cost reduction, the efficiency of 25 percent is cumulative because it includes the elimination of transportation costs, the reduction of installation costs, and VAT exemption which systematically reduces the entire operational cost structure. In terms of price, the combination of local production efficiency, VAT exemption, and tax holidays allows HJS to offer prices that are structurally unmatched by suppliers from outside the SEZ who bear the full burden of logistics and taxation.

Environmental Layers

Results of Field Observations

Environmental baseline observations were conducted to provide field-verified LCA benchmarks. The Tanjung Sauh SEZ area is currently still in a relatively clean baseline condition because there is no large-scale industrial activity. The area planned for the plant has a slope that allows for gravitational runoff management so that the WWTP system can be designed more efficiently. The ambient noise level in the area is still far below the maximum limit of 70 dB(A) set by the Ministry of Agriculture No. 48 of 1996 for industrial estates. For comparison, measurements at the precast concrete plant in Batam show that the operational noise level ranges from 70 to 80 dB(A) depending on the type of production activities taking place, so noise management through control engineering is still needed. The Tanjung Sauh SEZ BUPP has prepared an integrated waste management infrastructure referring to the Ministry of Environment and Forestry regulations, providing certainty that precast factory waste has a standardized management path. Dock observations confirm that shipments of raw materials are carried out in large quantities per cycle which inherently minimizes the frequency of barge trips and the marine transport emissions footprint as early empirical evidence of a projected reduction in transport CO_2 emissions of 25 to 30 percent.

Interview Results

SL said "HJS has been registered as a Tanjung Sauh SEZ Business Actor in its capacity as a contractor. The plan to establish a precast concrete plant requires additional permits in the form of the preparation of a Detailed RKL-RPL Addendum that explains all new activities including the types and specifications of waste produced from the production process. Waste discharged into the area management system must meet the standards of Category 1 of the Minister of Environment Regulation No. 5 of 2014 concerning wastewater quality standards. Compliance with this regulation is not just an administrative obligation but a real commitment to responsible environmental management in the Tanjung Sauh SEZ area."That is why

SL's statement confirms that compliance with the Detailed RKL-RPL Addendum is not a mere administrative obligation but a legally binding environmental commitment in the Tanjung Sauh SEZ

TT said "HJS is required to submit a Detailed RKL-RPL Addendum as a condition for environmental licensing for precast concrete manufacturing activities which is an expansion of construction activities that have been carried out. This document is not just an administrative formality but a comprehensive and legally binding environmental planning instrument, reflecting the company's real commitment to responsible environmental impact management from before operations begin. The Detailed RKL-RPL Addendum includes four main interrelated components. First, complete identification of activities starting from the factory construction stage, production operations, to post-operations so that the entire activity cycle is clearly mapped. Second, an environmental impact analysis that includes potential air pollution, water pollution, soil contamination, operational noise, and B3 waste management. Third, technical documents that contain the factory layout, production capacity, water sources, regional utility needs, and potential pollutant points that need to be identified and controlled. Fourth, a detailed environmental management and monitoring plan along with a commitment to solid, liquid, and B3 waste management. The preparation process requires HJS to actively consult with relevant agencies and comply with all regulations of the Ministry of Environment and Forestry. Operational impacts that need to be anticipated include dust emissions from the batching, cutting, and material handling processes; noise from production machinery and heavy equipment; as well as the potential for water pollution from concrete laundry waste and runoff from production areas. Control is carried out through the installation of dust collectors and filtration systems at the batching plant, wastewater management systems with adequate capacity, and storage of additive chemicals in closed and watertight areas. Post-life concrete waste is managed with circular economy principles through destruction into recycled aggregate to be reused as a base course, subbase, or non-structural concrete mixture. The use of fly ash from power plant waste is highly recommended because it reduces the need for cement while significantly reducing production CO_2 emissions. Its use refers to SNI 03-6866 and SNI 15-2049 from certified suppliers, accompanied by periodic monitoring of the proportion of mixtures and heavy metal content as a form of true environmental management commitment."

The TT statement confirms that the Detailed RKL-RPL Addendum is a comprehensive environmental management instrument that requires HJS to monitor all operational impacts through a circular economy system and SNI-certified fly ash substitution.

AM said, "The operational environmental impact of precast concrete manufacturing is considered to be very minimal because most of the main materials can be recycled, including pieces of rebar iron that are economically valuable and can be returned to the steel industry chain, so that solid waste that cannot be reused is very limited. The only waste that requires special handling is B3 waste in the form of oil from production machines that must be managed by a licensed third party, but the volume is very limited. Shipping bulk of raw materials each cycle minimizes the frequency and footprint of marine transportation emissions. Electricity

and water needs are met independently by the region through SEZ power plants and the BUPP water recycling system so that dependence on resources outside the region can be minimized"

The AM statement confirmed that the operational environmental impact of the precast plant is minimal due to the circular economy system, limited volume of B3 waste, and the region's self-sufficient infrastructure to minimize dependence on external resources.

Analysis

The analysis of the environmental layer of TLBMC answers the research question comprehensively through triangulation of three data sources that confirm the feasibility of the HJS environment in the Tanjung Sauh SEZ. The functional value block answers the why and what, that precast production within the region inherently results in lower CO_2 emissions than in-situ casts (Xu et al., 2023), with large quantities of raw material delivery per cycle that minimizes barge frequency and transportation emissions footprint by 25 to 30 percent. The environmental impacts block answers where and what, through field observations that identify the baseline condition of the Tanjung Sauh SEZ that is still clean with operational impacts including dust emissions, noise in the range of 70 to 80 dB(A), runoff of production areas, and B3 waste in the form of engine oil applied which is very limited. The supply and outsourcing block answered the who and how, confirmed by TT as an environmental expert with 16 years of experience at Panbil Group that the substitution of SNI 03-6866 certified fly ash is not a voluntary choice but an obligation of the Detailed RKL-RPL Addendum which is legally binding since the start of operations, answering when. The environmental benefits block answers how, through a circular economy system that includes recycling scrap of reinforcing iron and recycled aggregate from scrap concrete so that non-B3 solid waste is close to zero and at the same time strengthens TLBMC's economic layer through additional revenue streams.

Social Layers

Field Observation Results

Social observation identifies three phenomena that empirically confirm the social dimension. First, the presence of MSMEs around the Tanjung Sauh pier which includes food stalls, informal transportation services, and work equipment kiosks has been identified even though the area is new in the construction stage, as early empirical evidence of the social multiplier effect that occurs even before the precast factory operates. Second, most of the existing construction workers in the region are seasonal workers from mainland Batam and surrounding areas, so the presence of factories with permanent employment status will provide significant structural differences for the local community. Third, the region's social infrastructure that includes employee meals and access to basic health services has been identified in the advanced planning phase, confirming BUPP's commitment to worker welfare standards in remote areas.

Interview Results

WA said "The establishment of a precast concrete factory in Tanjung Sauh is projected to make a real and layered contribution to the local community's economy. The presence of this industry creates direct jobs within the factory while encouraging the growth of indirect jobs in the service, food, and trade sectors around the region. The increase in people's income drives local consumption through a multiplier effect that stimulates the growth of MSMEs, so that this factory is not just a production unit but a catalyst for local economic growth whose impact goes beyond the boundaries of industrial estates. The presence of formal workers with stable incomes improves people's quality of life through better access to education, health services, and decent housing. The recruitment approach does not solely focus on quantity but also on competency readiness, where gaps are bridged through pre-employment training programs, technical training, and certifications that leave a legacy of human capacity for the surrounding community in the long run. Remote location challenges demand a comprehensive SMK3 including hazard identification, risk assessment, clear SOPs, PPE availability,

emergency evacuation procedures, and access to basic on-site health services. The physical and mental well-being of employees is maintained through the provision of proper meals, nutritious meals, adequate rest areas, and means of entertainment to prevent psychological fatigue. ESG-based governance integrates all social commitments into a measurable system through local recruitment, equal opportunity, competency development, and a code of conduct that is integrated into the KPIs of all employees. The expected social benefits include increased absorption of local labor, improved human resource skills through continuous training and certification, and improved quality of life of the community through CSR programs in the fields of education, health, and community infrastructure."

The WA statement confirms that HJS's precast plant serves as a catalyst for local socio-economic growth through permanent employment, competency development, and measurable ESG governance.

AM said, "The production process is supported by experienced workers who are transferred from the project team to the production team through special training, with priority for the recruitment of new employees given to the local residents of Tanjung Sauh and Batam. Occupational safety is a top priority and part of the work culture, supported by management's commitment to employee welfare. The presence of precast manufacturing in the Tanjung Sauh SEZ ultimately accelerates the development of regional infrastructure while opening up wider job opportunities for the people of Batam and Tanjung Sauh."

AM's statement confirmed that the priority of local recruitment and the work safety culture makes the HJS precast factory a driver of sustainable community empowerment in Tanjung Sauh.

Analysis

The triangulation of the social layer of TLBMC answers research questions comprehensively through the convergence of field observations, WA and AM interviews, and mutually reinforcing academic literature. The local communities block answered where and who, confirmed through observation of the presence of MSMEs around the Tanjung Sauh pier as empirical evidence of the social multiplier effect that occurred even before the factory operated, in line with Akanpaadgi (2023) that authentic CSR programs build mutually beneficial social relationships. The social value block answers the what and why, WA confirmed that this factory is not just a production unit but a catalyst for local economic growth that creates permanent jobs, increases income, and encourages the growth of MSMEs through multiplier effects that go beyond the boundaries of industrial estates. The block of employees replied how, confirmed by AM that recruitment priority is given to local residents of Tanjung Sauh and Batam with the competency gap bridged through pre-employment training and certification, in line with Ferdousi and Abedin (2023) that integrated local recruitment produces sustainable shared value. The governance block responded when, WA confirmed that ESG-based governance is integrated into the KPIs of all employees since operations began, ensuring that social commitments are measurable and can be audited periodically, not just voluntary statements.

Table 2 Economic Layer

Partners	Activities	Value Proposition	Customer Relationship	Customer Segments
• Concrete company • foreman • Contractor • Suppliers • barge owner	• Precast concrete production • Precast Concrete Installation • Supply Chain Management	• 25% cost efficiency compared to procurement from Batam	• Long-term contracts • Direct visits of investors to the factory for quality control	• Tanjung SEZ Manager • Heavy industry investors in the Tanjung Sauh SEZ • EPC contractor for regional

• BUPP SEZ Tanjung Sauh • Tanjung Sauh SEZ Administrator	• Quality Control & Production QC **Resources** • Factory land • Building • Production equipment • Heavy equipment • Trained human resources • Raw Material	• Faster time 2–3 weeks per shipment • Quality Assurance • Recycling with the sale of leftover production	**Channel** • Direct appointment	infrastructure projects

Costs
Investment in the form of factory building construction, purchase of production equipment & heavy equipment, HR training

Operations in the form of raw materials, payroll & employee accommodation, maintenance of machinery & facilities, income tax, stock accumulation of raw materials, barge costs & distribution logistics

Revenues
Precast concrete sales, installation services in the field, sales of waste iron / recycled scrap

Eligibility Indicator, IRR: 24%, Payback Period 4 years, NPV: Positive

Table 3 Environmental Layers

Supplies & Outsourcing • Dust collector & filtration system in batching plant • Wastewater management of washing mixer, curing, runoff • Storage of chemical additives in watertight areas	**Production** • Modular system with steel mold • Quality control (QC) in the factory • Raw material stock management **Materials** • Cement • Reinforcement iron • Fly ash from waste coal-fired power plants Chemical additives	**Functional Value** • Production is not affected by the weather • Consistent quality • Bulk bulk shipment of raw materials • Standalone power plant Regional water recycling system	**End-of-Life** • Used concrete is crushed into recycled aggregate • The rest of the reinforcement pieces are sold as recycled iron scrap **Distribution** • Bulk bulk shipment of raw materials • Distribution of precast products using trucks	**User Phase** • Precast concrete products installed as SEZ infrastructure (±300 km channel, etc.) • Long lifespan Quality assured vs in-situ cast

Environmental Impacts
Dust, cutting, and material handling emissions, operational noise of production machinery and heavy equipment, runoff of production areas, and water curing, increased CO_2 emissions from the use of cement and material transportation and limited B3 waste in the form of applied oil with wastewater quality standards refer to the Minister of Environment and Forestry Regulation No. 5/2014 Category 1.

Environmental Benefits
Reduction of CO_2 emissions of transportation by 25–30%, use of fly ash to reduce the need for cement & CO_2 emissions in the production process, recycled aggregate from used concrete, sale of scrap reinforcing iron, delivery of raw materials in bulk

Table 4 Social Layers

Local Communities • Residents around Tanjung Sauh Island • Local workforce • MSMEs around the area	**Governance** • Hazard identification & risk assessment • Clear & standardized work SOPs • PPE according to standards, • Emergency evacuation procedures • Access to basic health services	**Social Value** • Direct and indirect job creation • Decline in local unemployment rate • Increase in income and quality of life of the community • Multiplier effect of local consumption	**Social Culture** • Occupational safety as a top priority • Care for the environment • Fair and transparent employment practices • Employee well-being • ESG values are the behavior of all employees	**End-user** • Industrial Estate Manager • Industrial investors
	Employees • Decent housing • Employee well-being • Support for the physical and mental condition of workers • Employee Development		**Scale of Outreach** • Direct labor • Indirect labor	
Social Impact • Direct job creation (operators, technicians, staff, plant management) • Priority recruitment of local residents of Tanjung Sauh & Batam • Reduction of unemployment rate in areas around SEZs • Increase in income and well-being of employees and their families		**Social Benefits** • Increased absorption of local labour force (measured by the number of recruitment & decrease in unemployment) • Upskilling of local human resources through technical training & certification • Improving quality of life: access to education, health and decent housing • Harmonious social relations between companies, workers and society		

TLBMC's vertical analysis reveals the inter-layered linkages that form a chain of self-reinforcing, answering the research question that the multidimensional feasibility of PT HJS is not just a partial feasibility per dimension but a systemic feasibility born from the interaction of the three layers simultaneously.

Vertical Analysis between Economic and Environmental Layers

Economic and environmental relations are bidirectional and mutually reinforcing. In terms of what and why, the 25 percent savings in logistics costs are directly correlated with a reduction in transportation emissions because every shipment from Batam that is eliminated means that CO_2 emissions are measurably prevented. Fly ash substitution works on two dimensions at once, namely lowering the cost of cement as an economic benefit and reducing CO_2 emissions of production as an environmental benefit. In terms of how, recycling reinforcing scrap iron generates additional revenue streams that at the same time reduce solid waste, proving that economic and environmental decisions in the Tanjung Sauh SEZ cannot be optimized separately. In terms of when, a 25 to 30 percent reduction in transportation emissions occurred from the first day of operation without requiring additional technological

investment because it was born from the decision of the production site itself, in line with the findings of Xu et al. (2023) that precast production produces lower emissions than structurally in-situ casting.

Vertical Analysis between Economic and Social Layers

Economic and social relations form dynamic capabilities that determine business sustainability in the long term. In terms of what, financial feasibility with an IRR of 24 percent and a positive NPV allows adequate budget allocation for HR training, SMK3, and CSR programs consistently over a 10-year horizon. In terms of why, without a strong financial foundation social commitment cannot be sustained. In terms of how, WA and AM's confirmed investment in local HR training results in a skilled workforce that lowers turnover costs and increases productivity, ultimately strengthening profitability. Social capital built through local recruitment and CSR programs reduces the risk of operational conflicts that often arise when industries are present in remote areas without meaningful community involvement. From the side of the who, the captive market through the status of SEZ Business Actors confirmed by SL protects local workers from seasonal work cycles, making the social impact structural and long-term as confirmed by Ferdousi and Abedin (2023).

Vertical Analysis between Environmental and Social Layers

Environmental and social relations reflect the principles of environmental justice that are relevant in the context of remote areas. In terms of what, orderly management of emissions and waste through the Detailed RKL-RPL Addendum improves the quality of the work environment which has a direct impact on workers' health and reduces the risk of work-related diseases, a dimension that is very crucial in Tanjung Sauh considering that access to external medical facilities requires sea travel. In terms of how, local workers who receive training based on environmental awareness become agents of internal change that encourage environmentally friendly production practices from within the organization. From a who's and where's perspective, the involvement of local communities in environmental monitoring of the region creates a social accountability mechanism that complements formal environmental management systems and builds trust between companies and surrounding communities.

Vertical Analysis between Economic, Environmental and Social Layers

The integration of the three layers results in an integrative proposition that definitively answers the research question. The decision to establish a factory within the Tanjung Sauh SEZ is a single strategic decision that simultaneously creates economic value through 25 percent efficiency and fiscal incentives for SEZs, environmental value through a 25 to 30 percent reduction in transportation emissions without additional technology investment, and social value through permanent employment for local communities that previously only had access to seasonal jobs. No single layer can be partially optimized without strengthening the other, making this business model systemically sustainable.

Managerial Implications

The managerial implications of TLBMC's horizontal and vertical analysis are based on three interlocking pillars. Economically, HJS needs to formalize a long-term B2B contract with BUPP as an anchor customer, maintain a four- to six-week stock buffer to mitigate the risk of northerly winds, implement a 15 to 20 percent fly ash substitution, and actively manage three revenue streams to maintain cash flow stability.

Environmentally, the completion of the Detailed RKL-RPL Addendum must be carried out in parallel with the preparation of the factory construction so that the operational permit does not hinder the schedule that has an impact on the economic layer. The circular economy system including the recycling of scrap, reinforcing iron and recycled aggregate needs to be operationalized from the first day of production because it also generates additional revenue streams that strengthen the economic layer. Socially, the pre-employment training program needs to start in Q2 2026 so that the local workforce is ready to absorb all available positions.

A minimum recruitment commitment of 70 percent of the local workforce is integrated into the KPIs of all management as a measurable accountability mechanism. The integrative proposition of the entire analysis is that the decision to establish a factory within the Tanjung Sauh SEZ locks in all three dimensions of the 3P simultaneously, making HJS's business model systemically sustainable and cannot be replicated by competitors from outside the region.

CONCLUSION

Based on TLBMC's analysis which includes three layers in an integrated manner and validated through triangulation of sources, methods, and data, the establishment of a precast concrete plant by PT Harapan Jaya Sentosa in the Tanjung Sauh SEZ is declared feasible multidimensionally from an economic, environmental, and social perspective. Economically, financial feasibility is confirmed through a 24 percent IRR, a four-year payback period, and a positive NPV that is strengthened by a cost efficiency of 25 percent compared to procurement from Batam, SEZ fiscal incentives in the form of VAT exemption and tax holidays of 10 to 20 years, and a captive market through the status of SEZ Business Actors which ensures demand stability in the first 10 years. The six components of the value proposition can only work simultaneously within the Tanjung Sauh SEZ and cannot be replicated by competitors from outside the area. Environmentally, feasibility is confirmed through a 25 to 30 percent reduction in transportation CO_2 emissions from the first day of operation without additional technology investment, SNI 03-6866 certified fly ash substitution that reduces production emissions as well as cement costs, and a circular economy system that is validated through a legally binding Detailed RKL-RPL Addendum. Socially, feasibility is confirmed through a minimum recruitment commitment of 70 percent of local workers integrated into management KPIs, comprehensive SMK3 which is crucial in remote contexts without land access, measurable ESG governance, and social multiplier effects that have been empirically observed through the presence of MSMEs around the dock even before the factory operates. The integrative proposition of this study is that the decision of production sites within remote island SEZs is a single catalyst that simultaneously creates economic efficiency, environmental benefits, and social legitimacy as an interlocking chain of causality, making the HJS business model systemically sustainable and cannot be partially optimized without strengthening all other dimensions.

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