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Beyond Connectivity: Quantifying the Economy-Wide Impact of Non-Toll Road Preservation via Public-Private Partnerships

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Abstract

The escalating imperative for resilient infrastructure in developing economies often competes with fiscal constraints, necessitating innovative financing models such as Public-Private Partnerships (PPP). While extensive literature examines the economic impact of new toll road construction, empirical evidence regarding the economy-wide valuation of non-toll road preservation remains scarce. This study investigates the national economic repercussions of the South Sumatra Eastern Highway preservation project, Indonesia's inaugural non-toll PPP initiative, employing a rigorous Input-Output analysis updated to 2023. By integrating Keynesian multipliers with Hirschman's unbalanced growth theory, the research quantifies the project's capacity to catalyze sectoral linkages. The findings reveal that the preservation investment generates a total output multiplier of 1.76, creating substantial employment opportunities, primarily within the construction sector. Furthermore, the analysis uncovers significant compulsive backward linkages, where the preservation activities actively stimulate upstream industries, particularly manufacturing and wholesale trade, despite these sectors not receiving direct investment. These results challenge the perception that maintenance projects yield lower economic returns than new construction. This study provides a robust justification for expanding PPP schemes in asset preservation, demonstrating that strategic maintenance is not merely a cost but a potent driver of intersectoral economic growth and structural development.

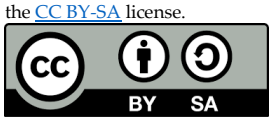
Kata kunci:
Dampak Ekonomi;
Analisis Input-Output;
Kerja sama Pemerintah dan Badan Usaha;
Preservasi Jalan.

Abstrak

Urgensi penyediaan infrastruktur tangguh di negara berkembang sering kali berbenturan dengan keterbatasan fiskal, sehingga memerlukan model pembiayaan inovatif seperti Kerjasama Pemerintah dan Badan Usaha (KPBU). Meskipun literatur mengenai dampak ekonomi pembangunan jalan tol baru sangat luas, tetapi bukti empiris terkait valuasi ekonomi dari preservasi jalan non-tol masih terbatas. Penelitian ini menginvestigasi dampak ekonomi nasional dari proyek preservasi Jalan Lintas Timur Sumatera Selatan inisiasi KPBU non-tol pertama di Indonesia menggunakan analisis Input-Output yang dimutakhirkan ke tahun 2023. Dengan mengintegrasikan efek pengganda Keynesian dan teori pertumbuhan tidak seimbang Hirschman, penelitian ini mengukur kapasitas proyek dalam mengkatalisasi keterkaitan antarsektor. Temuan menunjukkan bahwa investasi preservasi menghasilkan *output multiplier* sebesar 1,76 dan menciptakan lapangan kerja yang signifikan, terutama di sektor konstruksi. Lebih jauh, analisis ini mengungkap adanya keterkaitan ke belakang (*backward linkages*) yang kuat, di mana aktivitas preservasi secara aktif menstimulasi industri hulu, khususnya manufaktur dan perdagangan besar, meskipun sektor-sektor tersebut tidak menerima investasi langsung. Hasil ini menantang persepsi bahwa proyek pemeliharaan memberikan imbal hasil ekonomi yang lebih rendah dibandingkan konstruksi baru. Studi ini memberikan justifikasi yang kuat untuk memperluas skema KPBU dalam preservasi aset,

membuktikan bahwa pemeliharaan strategis bukan sekadar beban biaya, melainkan pendorong pertumbuhan ekonomi antarsektor yang vital.

Article info



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1. Introduction

Global economic, social, and environmental pressures have catalyzed a collective vision for transnational development, reflected in the United Nations' 17 Sustainable Development Goals (SDGs) (Pauliukevičienė et al., 2025; Rai et al., 2019). Among these, SDG 9 specifically emphasizes the need for resilient infrastructure, inclusive and sustainable industrialization, and robust innovation (Grodzicki & Jankiewicz, 2024). This goal promotes investment in high technology, research, and infrastructure as primary drivers for economic growth, enhanced employment opportunities, and sustainable resource management (Kazan et al., 2025). Infrastructure investment also plays a crucial role in reducing economic inequalities, particularly in developing nations (Küfeoğlu, 2022). Consequently, infrastructure is recognized as a strategic enabler for achieving 72% of all SDG targets, including SDG 8, which concerns decent work and economic growth (Thacker et al., 2019).

Within this framework, road infrastructure serves as a fundamental component of land transport, establishing essential connectivity between regions and acting as a catalyst for national economic growth (Tanjung et al., 2023; Yu, 2017). Significant public and private investment in road projects reflects their strategic importance in facilitating the movement of goods and services (Khanani et al., 2021). Beyond their primary function, road networks generate substantial indirect economic benefits, including reduced production and distribution costs, increased efficiency in the use of factor inputs, and the expansion of employment opportunities (Möller & Zierer, 2018; Tian et al., 2023). This enhancement of logistical efficiency translates into more competitive market prices, expanded market reach, and improved product competitiveness (Andrus, 2024; Rodrigue, 2020). Furthermore, improved connectivity resulting from road development enhances regional accessibility, which in turn stimulates new investment and business activities (Karnoto et al., 2024). Reliable road infrastructure is therefore indispensable for supporting the economic activities of government, the private sector, and households.

Despite this importance, the provision of reliable road infrastructure presents a formidable global challenge, characterized by funding uncertainties and intense competition among development priorities (Ben, 2019). Road infrastructure consistently requires the largest share of investment compared to other types; developing countries are estimated to require annual investments of 1.7% of their GDP, while low-income developing countries face a much higher requirement of 5.2% of GDP (Välilä, 2024). This demand for funding also competes directly with critical social sectors such as health and education (Välilä, 2024).

As a developing nation, Indonesia faces an urgent and escalating need for infrastructure investment to support economic growth and ensure equitable development (Ardalepa, 2023; Rijal et al., 2023). The Ministry of Finance estimated national investment needs at Rp26,558 trillion for the 2015–2019 National Medium-Term Development Plan (RPJMN) period alone (Pashya et al., 2025). Connectivity and economic infrastructure have remained central to the national agenda, as reflected in the RPJMN for the 2015–2019 and 2020–2024 periods, which specifically targeted improvements in national road stability and the preservation of key corridors.

However, Indonesia continues to grapple with a significant infrastructure deficit, a legacy of historical underinvestment and weak asset management (Ray & Ing, 2016). Indonesia's annual infrastructure financing requirement is estimated at USD 50–60 billion, an amount that far exceeds the government's fiscal capacity to meet it, leading to a persistent investment gap (World Bank, 2024). This challenge is compounded by the inherent characteristics of infrastructure projects, which include large capital requirements, high risk, low returns, and long payback periods (Economic Research Institute for ASEAN and East Asia, 2023).

To address this financing gap, Indonesia has increasingly adopted the Public-Private Partnership (PPP) scheme, known locally as Kerjasama Pemerintah dan Badan Usaha (KPBU). This strategy is intended not only to mobilize private capital, which is projected to cover a substantial portion of national infrastructure needs. It further seeks to facilitate risk-sharing and draw on private-sector efficiency and technical expertise to enhance project performance (Zhang et al., 2018).

The preservation project for the South Sumatra Eastern Highway is a key example of this strategy. It represents the first application of the KPBU scheme for a non-toll national road in Indonesia (Kementerian Pekerjaan Umum, 2021). The project's classification as "preservation," as defined by Ministry of Public Works Regulation No. 13/2011, includes both maintenance and reconstruction activities. With a total investment of Rp982 billion, the project encompassed 29.87 km of road,

14 bridges, and supporting facilities such as weighing stations (Direktorat Jenderal Bina Marga, 2022).

This project represents a strategic innovation in non-toll road financing, where private investment functions as the primary capital driver over a 15-year concession period. Unlike conventional preservation projects that depend on reactive, short-term repairs, the scheme applies an Availability Payment (AP) mechanism that requires strict compliance with outcome-based Road Performance Indicators. This framework incentivizes the private partner to adopt a proactive maintenance strategy by anticipating and addressing potential failures before they occur, thereby maintaining continuous service quality rather than merely reacting to damage (Chen et al., 2017). Consequently, the project reframes road preservation from a fragmented annual activity into a long-term, systematically planned investment that secures asset performance and reduces future economic uncertainty.

Its strategic significance stems from its location along the Eastern Highway, a vital logistics corridor that has supported Sumatra's economic activity since the early 20th century (Ariwibowo, 2018). As part of the Trans-Sumatra network, it facilitates the primary flow of goods between Java and Sumatra (Putri & Firdaus, 2025). Its preservation is therefore expected to strengthen national distribution systems and support long-term economic growth.

Despite the strategic importance of road preservation, academic studies examining the economic impacts of such projects remain limited. Many existing studies focus on institutional aspects, such as maintenance prioritization using the Analytical Hierarchy Process (AHP) (Prayoga et al., 2023), or on environmental impacts, such as energy consumption and greenhouse gas emissions (Maulida et al., 2024). Some economic studies have estimated local welfare impacts using regression analysis (Gertler et al., 2024), but comprehensive national-level assessments that capture multisectoral effects remain scarce. This lack of robust analysis risks producing biased or incomplete valuations of preservation projects (Jatayu et al., 2024).

Beyond avoiding valuation bias, a comprehensive national-level assessment is strategically indispensable for policymakers to prioritize public fund allocation amid tight fiscal constraints (Dimitriou, 2017). By quantifying the economy-wide value-added, this study provides the empirical basis to justify why capital-intensive preservation projects warrant significant long-term investment compared to other competing infrastructure needs. Furthermore, demonstrating a robust positive impact on national growth and competitiveness serves as a critical signal to attract private equity and investors, validating that road preservation PPPs are

not merely cost centers but productive assets that sustain the broader national logistics system.

Input-Output (IO) analysis offers a rigorous method for addressing this gap. IO models provide a detailed representation of the national economy, capturing supply chains and intersectoral linkages (Di Noia et al., 2025; Uku & Shehu, 2024). This framework enables quantification of how an exogenous shock, such as infrastructure investment, affects output, income formation, and labor demand across sectors (Kim et al., 2024). Prior studies in Indonesia have used IO analysis to evaluate toll road construction, such as the Jakarta–Cikampek II Elevated Toll Road (Usman, 2020), the Balikpapan–Samarinda Toll Road (Tarassyta & Auwalin, 2024), the Surabaya–Mojokerto Toll Road (Khoiro, 2019), and the Cipularang Toll Road (Anas et al., 2017). However, these applications have thus far centered on toll road construction, resulting in a notable absence of empirical evidence on preservation projects.

Given the preceding context, examining the economic impact of the South Sumatra Eastern Highway Preservation Project becomes highly relevant. As the first PPP-based preservation initiative for a non-toll national road, the project represents a strategic effort to strengthen interregional connectivity and reduce logistics inefficiencies along a major national corridor. Its substantial investment value and critical geographic role warrant an assessment of whether a preservation project of this scale can deliver economic benefits comparable to those typically associated with new toll road developments.

At the same time, studies evaluating the economic impact of non-toll national road preservation projects remain limited, particularly those employing IO analysis at the national level. This gap leaves the economic value of preservation investments empirically underexamined and risks reinforcing the perception that preservation yields lower economic returns than new construction.

Therefore, this study aims to analyse the economic impact of the South Sumatra Eastern Highway Preservation Project on the national economy using an IO analysis and to identify the sectors most affected by the investment. By doing so, the research demonstrates how preservation projects can generate broad economy-wide linkages and contribute meaningfully to infrastructure policy, public investment justification, and the future expansion of non-toll PPP initiatives.

2. Literature Review

Empirical Studies on Infrastructure Preservation and Economic Impact

Input–Output (IO) analysis has been widely applied in Indonesia to estimate the economy-wide impacts of infrastructure investment. However, a review of recent literature indicates that existing studies predominantly concentrate on new construction projects, such as toll roads, airports, and dams, while the economic implications of infrastructure preservation receive comparatively limited attention. Most Indonesian IO-based studies simulate capital injections into the construction sector and consistently show strong multiplier effects associated with large-scale infrastructure expansion.

For example, Annisa et al. (2024) and Usman (2020) demonstrated that investments in the Trans-Sumatra and Jakarta–Cikampek II Toll Roads generated substantial output multipliers across the national economy. Similarly, Listikarini & Harlan (2024) and Sabila et al. (2024) reported significant spillover effects from the construction of Yogyakarta International Airport and the Bener Dam. Collectively, these studies reinforce the dominant narrative that new infrastructure development acts as a major economic stimulus, particularly for construction and manufacturing sectors.

In contrast, international research has increasingly recognized infrastructure maintenance as an economically meaningful form of investment. This shift in perspective is driven by growing evidence that poor infrastructure quality and inadequate maintenance can impose significant economic losses and hinder long-term economic growth (Anthony et al., 2024; Mwakatobe et al., 2023). Furthermore, Govender (2019) argues that maintenance strategies should be elevated to the same strategic importance as new infrastructure development, emphasizing their critical role in job creation and broader socio-economic progress.

Evidence from the United Kingdom indicates that highway maintenance funding delivers high value for money by mitigating wider societal costs, particularly in terms of vehicle operating costs and user time savings (Thiessen et al., 2017). In the United States, Ke et al. (2019) further demonstrate that pavement and bridge preservation projects contribute positively to gross regional product, including personal income and employment, through significant multiplier effects.

Moving to the context of developing economies, Chaurey & Le (2022) provide causal evidence from India that grants specifically targeting the maintenance and improvement of existing rural infrastructure significantly boost microenterprise growth and village-level employment. Complementing this, research in Guinea-Bissau utilizing dynamic CGE simulations highlights that road

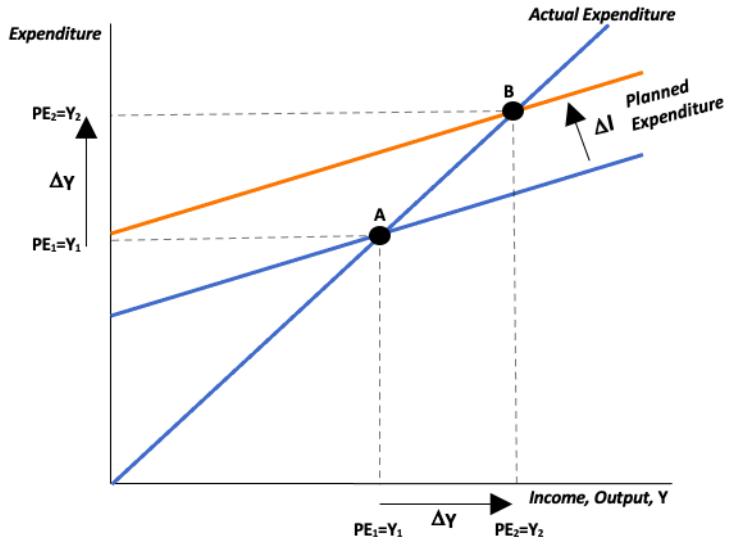
maintenance investments generate productive externalities that fundamentally strengthen the macroeconomic framework. These investments are shown to drive long-term economic growth by enhancing sectoral productivity and stimulating capital accumulation, even benefiting sectors not directly targeted by the initial spending (Cateia & Savard, 2025).

Despite this growing international evidence, empirical assessments of the economic returns to road preservation in Indonesia remain limited, particularly within the context of PPP schemes. Emerging studies indicate that road preservation can generate substantial economy-wide benefits that remain underexamined in domestic literature. This study addresses that gap by applying IO analysis to the South Sumatra Eastern Highway preservation project, aiming to evaluate the broader economic contributions of maintaining existing infrastructure alongside the traditionally emphasized benefits of new construction.

Keynesian Economic Growth Theory

Economic discourse spans from Adam Smith's Classical view of minimal state intervention to Neoclassical models like Solow's focus on capital, labor, and technology, yet both frameworks fall short in explaining persistent market disequilibria, especially during severe crises such as the Great Depression (Amalia et al., 2016; Z. Huang et al., 2019; Meirizal et al., 2024). Keynesian theory emerged to address these limitations by arguing that economic stagnation results from insufficient aggregate demand, thereby justifying active government intervention to counter deflationary pressures and stabilize short-term output and employment (Ghisellini et al., 2021; Mankiw, 2016; Pensieroso & Restout, 2018).

Figure 1. Investment Increase in the Keynesian Cross Model



Source: Mankiw (2016)

Within this framework, the Keynesian cross model shows that equilibrium occurs when actual expenditure equals planned expenditure, and an increase in investment as an exogenous component of planned expenditure shifts the PE curve upward, triggering a multiplier process that moves the economy to a higher level of income and output (Mankiw, 2016). The investment multiplier ($\Delta Y/\Delta I$) explains how an initial capital injection such as the South Sumatra Eastern Highway preservation project sets off successive rounds of spending, as investment becomes income that is partly consumed according to the marginal propensity to consume, thereby amplifying aggregate demand and producing increases in output, household income, and employment that exceed the initial outlay (Dalimunthe & Hasri, 2023; Mars & Sugiyanto, 2024).

Unbalanced Growth Theory

While Keynesian theory explains overall economic activity, it does not address the sequence of structural development, a gap filled by Hirschman's Unbalanced Growth Theory (1958), which rejects the impractical balanced growth approach for resource-constrained developing economies and instead advocates concentrating limited resources in key strategic sectors to trigger wider economic expansion (Jiang et al., 2020; Yotopoulos & Lau, 1970). Central to Hirschman's theory is the distinction between Social Overhead Capital (SOC) and Direct Productive Activities (DPA), and Hirschman argued that deliberate imbalances between them create inducement mechanisms that stimulate subsequent investment, such as SOC investment prompting additional investment in DPA (Saliminezhad & Lisaniler, 2018).

These inducements are transmitted through intersectoral linkages. Backward linkages exert a "compulsive" effect, where an expanding sector creates high demand for inputs, forcibly stimulating upstream suppliers (demand-pull). Conversely, forward linkages provide a "permissive" effect, where the increased availability of a sector's output encourages the growth of downstream industries (supply-push) (Frank, 1960). By positioning the Jalintim Sumsel project as a strategic SOC investment, this study uses Hirschman's framework as an interpretive lens to suggest that the observed disequilibrium can create backward linkage pressures between leading and lagging sectors, which may support wider economic growth.

Input-Output (IO) Model

The IO model developed by Leontief uses input–output tables to depict the flow of goods and services among industries and, by treating the economy as a system of linear equations, allows researchers to trace how shocks in one sector

spread through the entire economic system (Bjerkholt, 2016; Bunsen & Finkbeiner, 2022; Xu & Liang, 2019). Within the IO model, each sector's output is distributed either to other sectors or to final demand, while its inputs come from other industries and primary factors, creating a dual accounting structure that ensures total inputs equal total outputs across the economic matrix (Ariutama et al., 2022; Miller & Blair, 2009). The IO model's analytical strength lies in its capacity to quantify total production requirements—direct, indirect, and induced—resulting from an exogenous change in final demand, using the Leontief inverse to reveal how an initial demand shock triggers sequential production and income responses across interconnected sectors (Giannakisa & Mamuneas, 2022).

These sequential responses are structurally transmitted through sectoral linkages, which reflect the interdependence between industries. Intersectoral linkages sustain economic momentum by enabling spillover effects across industries, as sectors with strong upstream and downstream connections captured through backward linkages that reflect demand pull on suppliers and forward linkages that reflect supply push on users serve as engines of growth and help identify which sectors can most effectively transmit investment shocks throughout the economy (Mehra, 2025; Rodousakis & Soklis, 2024; Su & Yao, 2016).

To capture the full extent of these relationships, this study adopts Rasmussen's approach to measuring total linkages, which supersedes simpler direct linkage methods. Rasmussen's method utilizes the Leontief inverse matrix to capture both direct and indirect repercussions of a demand shock (Fabian, 2025). The strength of these linkages is measured through two indices: the Index of Backward Linkage (IBL), which indicates how much a unit increase in final demand for a sector's output stimulates production in other sectors, and the Index of Forward Linkage (IFL), which shows how strongly a sector is relied upon to supply inputs when overall production in the economy rises; by normalizing these values to the national average, researchers can determine whether a sector's influence is above or below the economy-wide norm (Arifin & Suryawati, 2017; Tariyal, 2017).

Table 1. Priority Sector Classification Derived from IBL and IFL Values

IBL	IFL	Sector Classification	Priority
> 1	> 1	Key Sector	I
> 1	< 1	Strong Backward Linkage Sector	II
< 1	> 1	Strong Forward Linkage Sector	III
< 1	< 1	Weak Linkage Sector	IV

Source: Rafiqah et al (2018)

Based on the values of IBL and IFL, sectors can be grouped into four categories: Key Sectors with both indices above one that influence the economy through strong demand and supply channels; Strong Backward Linkage Sectors which primarily drive upstream growth; Strong Forward Linkage Sectors which support downstream industries; and Weak Linkage Sectors which operate with relatively limited interdependence, allowing policymakers to see where economic impacts are most concentrated (Bartóková, 2019; Muchdie & Imansyah, 2020; Rafiqah et al., 2018).

While linkages identify the direction of structural interdependence, the magnitude of the resulting economic impact is quantified using the multiplier effect. The IO framework posits that an initial injection of capital into an economy generates a final increase in aggregate income that exceeds the original investment amount (Bhusal, 2024). In the context of IO analysis, multipliers are derived from the Leontief inverse matrix and account for direct, indirect, and induced effects of a demand shock (Miller & Blair, 2009).

This study focuses on three specific types of multipliers to capture the multidimensional impacts of the road preservation project. The Output Multiplier measures the total value of production generated across all sectors for every unit of final demand change (Giannakisa & Mamuneas, 2022). The Income Multiplier estimates the impact on household earnings, calculated by combining the Leontief inverse with the value-added or wage coefficients of each sector (Zhao & Ding, 2024). Finally, the Employment Multiplier quantifies the total number of jobs created, linking production changes to labor coefficients (Keček et al., 2022). These multipliers furnish a holistic and rigorous quantitative account of the project's capacity to catalyze economic activity at the national scale.

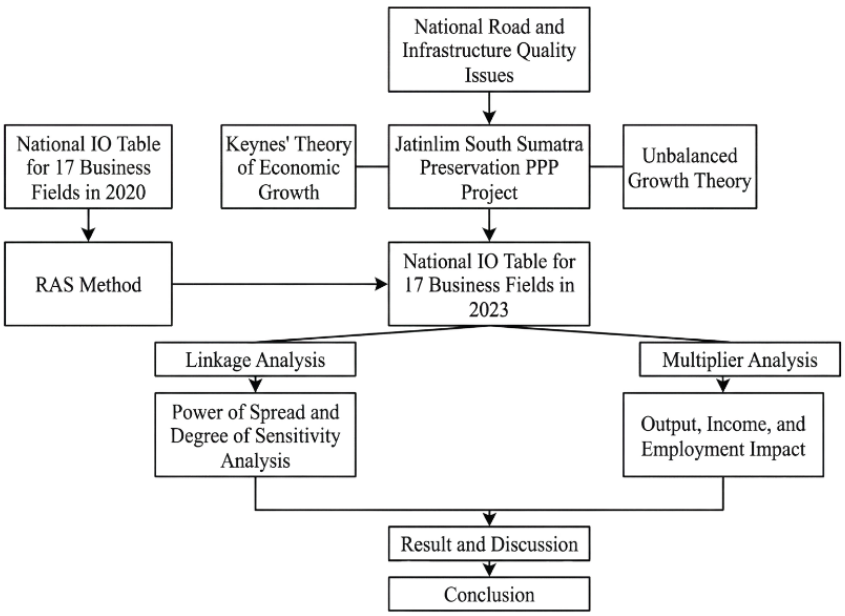
Conceptual Framework

This research is conceptualized to address the central challenge of national infrastructure quality, which impedes logistical efficiency and economic connectivity. The South Sumatra Eastern Highway preservation project, executed via a KPBU scheme, serves as the primary intervention for this analysis. The theoretical foundation integrates two main economic theories, namely Keynesian Economic Growth Theory and Hirschman's Unbalanced Growth Theory.

The analytical methodology to test these theories is the IO analysis. The National IO table, updated to 2023 using the RAS method, serves as the database. The investment value is treated as an exogenous shock to the final demand of the relevant sectors. The empirical investigation proceeds through two stages. First, linkage analysis using IBL and IFL indicators is conducted to identify the structural

influence of the sectors involved. Second, multiplier analysis is implemented to estimate the total economic impacts generated, including outcomes on national output, household income, and employment. The results provide a quantitative assessment of the project's economic contribution, which forms the basis for the analysis, discussion, and policy implications.

Figure 2. Conceptual Framework



Source: Author(s)

3. Methods

Research Approach and Data Collection

This study employs a quantitative approach utilizing the Input-Output (IO) analysis method. As a top-down economic model, IO analysis was selected for its comprehensive ability to capture inter-sectoral dependencies and quantify the economy-wide impacts of exogenous shocks. Data collection was conducted using documentation techniques, relying on high-integrity secondary data obtained from authoritative government bodies and official project documents. To ensure methodological rigor and data reliability, this study utilizes three primary datasets:

1. National Input-Output Table (2020): The Domestic Transactions IO Table categorized into 17 industrial sectors was obtained from Badan Pusat Statistik (BPS), using the most recent official dataset published in 2025. This table serves as the baseline matrix for calculating sectoral linkages and the initial structure of the economy.
2. Project Overview and Financial Planning Data: Comprehensive data on project expenditure planning and feasibility were sourced from the Final Business Case

(FBC) document, obtained from the Directorate General of Financing and Risk Management (DJPPR), Ministry of Finance.

3. Realization Reports: Detailed actual expenditure reports and financial models were acquired from Balai Besar Pelaksanaan Jalan Nasional Sumatra Selatan and the implementing business entity, PT Jalintim Adhi Abipraya. These reports verify the specific allocation of funds across construction and operational categories, ensuring the analysis reflects realized spending rather than theoretical estimates.

Method and IO Table Selection

This study utilizes a National Input-Output (IO) table to accurately capture the comprehensive impact flow of the project. According to the Final Business Case (FBC) document, national non-toll roads proposed under the PPP scheme must fundamentally serve as major economic corridors or key national defense routes. Given this strategic function, a regional IO table is insufficient for analysis as the project's influence naturally transcends provincial boundaries.

This methodological choice aligns with Miller & Blair (2009), who emphasize that single-region IO models inherently fail to capture interregional spillover effects. Furthermore, standard regional estimation methods typically treat input-output tables and trade flows as separate problems, resulting in inconsistent estimates that lack the capability to support the analysis of interregional trade flows (Boero et al., 2018).

While an Interregional Input-Output (IRIO) framework theoretically offers the ability to map specific cross-regional linkages, it was deemed unsuitable for this study due to data relevance and estimation constraints. The most recent official IRIO and regional IO table was published based on 2016 data and only released in 2021, creating a significant temporal lag that diminishes its relevance for analyzing the 2021–2023 project period.

Attempting to update this matrix to the current year using the RAS method presents substantial challenges, as the convergence process is computationally demanding and requires highly granular sectoral GDP data across 34 provinces. These data limitations raise concerns that an estimated IRIO model would fail to accurately reflect the post-pandemic economic structure, potentially yielding less reliable estimates compared to the updated National IO table used in this research.

Analytical Framework and Updating Procedure

This study employs the standard Input-Output framework developed by Leontief to capture the structural interdependence of the economy. The

fundamental balance equation of the IO model posits that the total output of sector i (x_i) is the sum of intermediate demands from other sectors (x_{ij}) and final demand (f_i), expressed as:

$$x_i = \sum_{j=1}^{n} x_{ij} + f_i$$

Where x_{ij} represents the flow of goods from sector i to sector j. By assuming a fixed production technology where inputs are proportional to output, the technical coefficient (A) is derived as:

$$A = \frac{x_{ij}}{x_j}$$

In matrix notation, the IO balance relationship is written as X = AX + F, which can be rearranged to solve for total output required to satisfy final demand:

$$X = (I - A)^{-1}F$$

Where X is the vector of gross output, F is the vector of final demand, I is the identity matrix, and $(I - A)^{-1}$ is the Leontief Inverse Matrix (L), with elements l_{ij} representing the direct and indirect output required from sector i to produce one unit of final demand in sector j.

To identify key sectors, this study utilizes the linkage analysis proposed by Rasmussen (1956). The Total Backward Linkage (BL_j), which measures the total stimulus a sector j provides to upstream sectors, is calculated as the column sum of the Leontief inverse:

$$BL_j = \sum_{i=1}^{n} l_{ij}$$

Conversely, the Total Forward Linkage (FL_i), measuring the sensitivity of sector i to downstream demand, is the row sum of the Leontief inverse:

$$FL_i = \sum_{j=1}^{n} l_{ij}$$

To standardize these measures for cross-sectoral comparison, the indices are normalized by the global average of the Leontief inverse elements. The Index of Backward Linkage (IBL_j) is defined as:

$$IBL_j = \frac{n \sum_{i=1}^{n} l_{ij}}{\sum_{i=1}^{n} \sum_{j=1}^{n} l_{ij}}$$

Similarly, the Index of Forward Linkage (IFL_i) is expressed as:

$$IFL_i = \frac{n \sum_{j=1}^{n} l_{ij}}{\sum_{i=1}^{n} \sum_{j=1}^{n} l_{ij}}$$

Where n is the number of sectors. An index value greater than 1 indicates that the sector's linkage is above the national average.

Finally, to quantify the economy-wide impact of the preservation project, three types of multipliers are derived. The Output Multiplier (O_j) for sector j is simply the column sum of the Leontief inverse:

$$O_j = \sum_{i=1}^{n} l_{ij}$$

The Income Multiplier (DIH_j) captures the household income generation, calculated by weighting the Leontief inverse with the household income coefficient vector, where $\frac{H_j}{X_j}$ is the ratio of wages to gross output:

$$DIH_j = \sum_{i=1}^{n} l_{ij} * \frac{H_j}{X_j}$$

The Employment Multiplier (DIE_j) estimates the total jobs created, derived by interacting the labor coefficient vector, where $\frac{E_j}{X_j}$ is the ratio of direct labor employment to sectoral output, with the Leontief inverse:

$$DIE_j = \sum_{i=1}^{n} l_{ij} * \frac{E_j}{X_j}$$

These multipliers allow the study to estimate the total output, income, and employment generated by the exogenous investment shock injected into the construction and supporting sectors.

Given that Input-Output tables are not compiled annually due to the resource-intensive nature of survey-based estimation, this study employs the RAS method, originally introduced by Stone (1961), to update the 2020 National IO Table to the 2023 period (Suryaatmaja et al., 2023).

The RAS method is selected as a robust non-survey approach recognized for its computational efficiency and reliability in updating large-scale economic matrices (Lamonica et al., 2020). This study uses 2023 Gross Domestic Product (GDP) by industry at current prices as the primary exogenous input. Because the project investment is recorded in nominal terms, employing GDP at current prices ensures that the updated IO structure reflects prevailing economic conditions and incorporates inflation between the base and analysis years (Badan Pusat Statistik, 2023). This maintains price consistency between the investment shock and the economic matrix.

The RAS procedure updates the matrix iteratively to satisfy predetermined row and column constraints (Temursho et al., 2020). The target row and column control totals are constructed from the 2023 GDP by industry data and used as balancing constraints to reflect the updated economic structure. Based on these targets, the RAS procedure iteratively adjusts the base transaction matrix through the following steps (Torój, 2025):

1. Row scaling: The initial matrix A is premultiplied by a diagonal adjustment matrix R, whose diagonal elements represent the ratios of target row totals to the corresponding current row sums.
2. Column scaling: The matrix obtained from the first step (RA) is then postmultiplied by a diagonal adjustment matrix S, whose diagonal elements represent the ratios of target column totals to the corresponding current column sums.
3. Iteration: The updated matrix (RAS) replaces the previous matrix, and the row and column scaling steps are repeated until the adjusted matrix simultaneously satisfies the predetermined control totals within an acceptable convergence threshold.

It is important to explicitly acknowledge the methodological limitations of this procedure. The traditional RAS algorithm applies proportional adjustments to all matrix elements, which may distort coefficients in sectors where production technology remains stable or where only partial technological changes occur (Trinh et al., 2018). In addition, the method is mathematically restricted to non-negative matrices, limiting its ability to accurately represent negative entries such as subsidies or inventory adjustments commonly found in IO tables (Temursho et al., 2021). As a result, the procedure relies on the simplifying assumption of uniform substitution and fabrication effects across sectors (Miller & Blair, 2009). Nevertheless, in the absence of a more recent survey-based table, RAS remains the most defensible approach for approximating the current economic structure.

Incorporation of Project Investment into the IO model

To simulate the economy-wide impact of the South Sumatra Eastern Highway preservation project, the total investment is modeled as an exogenous shock vector (ΔF) injected into the final demand component of the Input–Output framework. The expenditure is classified as Gross Fixed Capital Formation (PMTB) rather than routine government consumption, consistent with the System of National Accounts (SNA 2008), which defines major rehabilitation and reconstruction that extend asset service life or enhance performance as capital formation. Given that the Jalintim Sumsel project involves extensive rehabilitation to achieve high performance standards and sustain road functionality over a 15-

year concession period, the investment is conceptually treated as the creation of long-term productive capital.

Prior to integration into the model, the investment data were adjusted to ensure consistency with the IO framework. Project expenditures were mapped to the relevant sectors of the 2023 IO table using the 2020 Indonesian Standard Industrial Classification (KBLI). Capital costs were allocated primarily to the construction sector, while the remaining expenditures were distributed to supporting industries, particularly financial and insurance services and business services.

In addition, the Value Added Tax (VAT) component was excluded from the investment value. This adjustment is necessary because the IO table is expressed at basic prices, which represent producer prices net of product taxes and margins as defined by Badan Pusat Statistik. From an economic evaluation perspective, VAT is treated as a transfer payment rather than a direct use of productive resources, ensuring that the shock vector reflects only real intersectoral transactions (Bech et al., 2006).

Mathematically, the impact of this adjusted exogenous shock is calculated by introducing the investment vector into the fundamental Leontief equation:

$$\Delta X = (I - A)^{-1} \Delta F$$

Where ΔX represents the vector of changes in total sectoral output, $(I - A)^{-1}$ is the Leontief Inverse Matrix derived from the updated 2023 IO table, and ΔF contains the allocated project investment values for impacted sectors, with elements for non-impacted sectors remain zero.

4. Results and Discussion

National IO Table Update in 2023

The 2023 National IO table projection shows an increase in total output value of IDR 4,595,417,790 million, or a 16.01% increase compared to the 2020 base year. This increase aligns with GDP growth at current prices, which reached IDR 5,448,995,300 million, a 35.28% increase over the same period. The increase in national output reflects the effective utilization of domestic resources across various economic sectors. In 2023, total national output is projected to reach IDR 33,295,668,316 million. The manufacturing industry is the largest contributor, accounting for 23.52% of total output. The construction, wholesale and retail trade sectors follow, with respective shares of 12.43% and 11.08%. Conversely, the water supply, waste management, and recycling sectors contribute the smallest share, at 0.06%. The order of contributions aligns with the adjusted results of the 2021

national IO table by Yusa (2021). These findings indicate that the construction sector consistently holds a strategic position in the national economy, with its contribution typically peaking in middle-income countries, such as Indonesia (Gül, 2017). This is linked to the nature of its output in the form of physical infrastructure such as roads, bridges, ports, energy facilities, and buildings that support the functioning of other economic sectors (Purwanto, 2025).

Despite stability in several key sectors, shifts in sectoral rankings between 2021 and 2023 indicate changes in the national output structure, with business services dropping from 10th to 15th as its contribution declined from 3.11% to 1.92% and financial and insurance services rising from 11th to 9th as its contribution increased from 3.09% to 3.31%. These findings align with Akita & Alisjahbana (2023), who identify post-pandemic structural shifts marked by declining contributions and contraction in business services as well as rising contributions in financial and insurance services. The decline in business services may be linked to surging mining and quarrying output and weak linkages to manufacturing (Kucera & Jiang, 2019; Van Neuss, 2019). Conversely, the strengthening of financial services is driven by digitalization and fintech expansion that accelerates capital flows to support business and economic recovery (Aryati et al., 2023; Sunaryono, 2022).

Backward Linkage Analysis

There are two types of linkages in sectoral linkage analysis, namely backward linkage (BL) and forward linkage (FL). Eight sectors have BL values above the national average, led by electricity and gas supply with the highest value of 2.508 indicating the strongest induced demand for other sectors' outputs, while nine sectors fall below the average, with agriculture, forestry, and fisheries recording the lowest value of 1.285 reflecting the weakest upstream input dependence.

The construction sector with a BL value of 1.7999 ranks fourth and relies primarily on manufacturing, mining and quarrying, and wholesale and retail trade for inputs, with manufacturing serving as the main supplier of intermediate goods such as fabricated metals, basic metals, wood, plastics, and machinery (Mona & Ehab, 2015). Meanwhile, the mining and quarrying industry acts as a key source of inputs, supplying construction materials via direct and intermediate pathways (Weldegiorgis et al., 2023). On the other hand, the mining and quarrying sector supplies construction materials like crushed stone and sand directly, while indirectly furnishing raw materials for manufacturing industries within the construction supply chain (Broos et al., 2016; Saka & Arowoiya, 2023).

The financial and insurance sector with a total BL value of 1.324 remains below the national average, yet its output growth stimulates increases in the information and communication, manufacturing, and business services sectors as part of the input supply chain. Output growth in the financial and insurance sector relies on digital platforms from information and communication services, increases demand for fixed assets produced by manufacturing through financial leasing, and requires professional and administrative services supplied by business services (Afolabi & Akanbi, 2024; Tan et al., 2023; Wójcik, 2020).

Similar to the financial and insurance sector, the business services sector has a BL value slightly below the national average at 1.643, with its strongest backward linkages found in the information and communication sector, the manufacturing sector, and the wholesale and retail trade sector. The business services sector shows strong backward linkages through its use of information and communication technologies to improve efficiency, support decision-making, and facilitate the external transfer of competencies (Lebar & Veljković, 2023; Saltari et al., 2013). In addition, its linkages with manufacturing reflect Product-Service Systems (PSS) in which manufactured products are bundled with professional services, while wholesale and retail trade contribute by distributing capital goods and intermediate inputs to professional, industrial, and commercial users as stated (Broos et al., 2016; Miroudot, 2019; Mroszczyk, 2008).

Forward Linkage Analysis

Sectors with the highest Forward Linkage (FL) values act as key supply-push drivers, with nine sectors exceeding the national average and electricity and gas showing the highest FL at 2.436. In contrast, eight sectors fall below the average, with health and social work recording the lowest FL at 1.0610, indicating minimal use of their output as production inputs.

Although the construction sector's BL is above average, its FL is relatively low at 1.1004, with its strongest forward linkages found in public administration, real estate, and mining and quarrying. Buildings and infrastructure produced by the construction sector support public administration, defense, and social security services (Alaloul et al., 2021). In addition, it forms key assets traded or leased in the real estate sector, including housing, industrial zones, and office buildings (Y. Huang et al., 2021). Meanwhile, the mining and quarrying sector depends heavily on physical infrastructure such as roads, pipelines, and ports provided by the construction sector (C. Liu & He, 2016; Weldegiorgis et al., 2023).

Next, the financial and insurance services sector records an FL value of 2.0444, making it the fourth highest forward-linked sector nationally, with its

strongest forward linkages directed toward wholesale and retail trade, manufacturing, and construction. The financial and insurance services sector supports wholesale and retail trade by facilitating financing programs and improving access to credit for Micro, Small, and Medium Enterprises (MSMEs) (Angelo, 2025). In addition, this sector strengthens manufacturing activities by providing funding and risk-management services that contribute to higher levels of innovation and operational efficiency (Batool et al., 2024; X. Liu et al., 2020). It also stimulates the construction sector by offering property-backed credit and project risk-management support, including in cases of payment delays to contractors and suppliers (Mona & Ehab, 2015; Shibani et al., 2024).

The business services sector, with an FL value of 2.2641 and the second-highest forward linkage, is most strongly connected to construction, manufacturing, and wholesale and retail trade, with construction relying heavily on its professional outputs such as engineering consulting and HR management services (Lapidus et al., 2023; Pimenova et al., 2016). The strong forward linkage of business services to manufacturing reflects its strategic role in boosting firms' innovation capacity through support for new process technologies and enhanced product design, development, and marketing (Evangelista et al., 2015). In addition, business services supply the wholesale and retail sector with advertising and e-commerce–based promotional services that help optimize sales and improve distribution efficiency (Alzyadat & Almuslamani, 2021).

Power of Dispersion and Sensitivity of Dispersion Analysis

After obtaining BL and FL values, power of dispersion (IBL > 1) and sensitivity of dispersion (IFL > 1) are assessed relative to national averages to indicate which sectors more strongly stimulate or respond to final demand (Junari et al., 2020).

Table 2. Priority Classification of 17 National Economic Sectors in 2023

Code	Sector	IBL	IFL	Priority
1	Agriculture, Forestry, and Fisheries	0.7749	1.2055	III
2	Mining and Quarrying	0.9039	1.3464	III
3	Manufacturing	1.0606	1.0066	I
4	Electricity and Gas Supply	1.5125	1.5163	I
5	Water Supply, Waste Management, and Recycling	0.9304	0.8502	IV
6	Construction	1.0852	0.6853	II

7	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	0.8651	1.0235	III
8	Transportation and Warehousing	1.0761	1.0988	II
9	Accomodation and Food Service Activities	1.0902	0.7349	II
10	Information and Communication	0.9568	1.1787	III
11	Financial and Insurance Services	0.7988	1.2733	III
12	Real Estate	0.8291	0.8682	IV
13	Business Services	0.9912	1.4101	IIII
14	Public Administration, Defense, and Compulsory Social Security	1.0709	0.6912	II
15	Education Services	0.8730	0.6730	IV
16	Health and Social Work Activities	1.1589	0.6608	II
17	Other Services	1.0223	0.7770	II

Source: Author(s)

Based on table 2, the distribution of sectors across the four priority groups differs from (Yusa, 2021), with this study identifying 3 sectors in priority I, 5 in priority II, 6 in priority III, and 3 in priority IV, compared with Yusa's findings of 1, 6, 6, and 4 sectors respectively. Compared with the previous findings, electricity and gas supply, followed by transportation and warehousing, each rise from priority II to priority I, while other services shift from priority IV to priority II. These changes indicate strengthened dispersion power and sensitivity in line with evolving economic structure and growth (Radebach et al., 2016).

Priority I sectors including manufacturing, electricity and gas supply, and transportation and warehousing act as key sectors with IBL > 1 and IFL > 1, indicating that their strong input and output dependencies enable investment to enhance efficiency and productivity across the production chain (Magacho et al., 2019). Next, priority II consists of strong backward linkage sectors with IBL greater than 1 and IFL less than 1, meaning that sectors such as construction, accommodation and food service, public administration, health and social work, and other services rely more on inputs than they supply, creating strong demand-pull effects on their upstream industries (Ojaleye & Narayanan, 2022).

Moreover, priority III consists of strong forward linkage sectors with IBL less than 1 and IFL greater than 1, meaning that six sectors, including agriculture, mining, wholesale and retail trade, vehicle repair, information and communication, financial services, and business services, serve primarily as key input suppliers whose output increases generate strong supply-push effects across the economy (Swasito & Aribawa, 2021). Finally, priority IV consists of independent sectors with both IBL and IFL below 1, meaning that water supply and waste management, real estate, and education services show weak backward and forward linkages and play a relatively minor role as input users or suppliers within intersectoral production flows.

The construction sector, classified as a strong backward linkage sector, relies heavily on inputs from other sectors while supplying relatively little to them, with its large intermediate input demand sourced from a limited set of specific sectors (Saka & Arowoiya, 2023). Its weak forward linkage, also observed in Bangladesh, Sri Lanka, and Nepal reflects the fact that only a small portion of its output is used as intermediate input while most is directed to final demand such as new construction (Ali et al., 2019).

Unlike construction, the financial and insurance sector falls under priority III as a strong forward linkage sector, indicating its role as a key supplier in production chains by mobilizing funds from savers to investors for productive economic activities. In addition, the financial sector facilitates payment transactions and provides essential insurance services that support business growth through risk transfer and loss compensation, making its stability crucial for maintaining a smooth financial system that underpins economic activity across other sectors (Dutta, 2024; Yang et al., 2020; Zheng, 2018).

The business services sector, like the financial and insurance sector, is a strong forward linkage sector whose outputs supply key inputs to many other industries by providing essential services such as auditing, marketing, and consulting (Savic, 2016; Wessel, 2022). Increased supply from this sector expands the range of available services and enables user industries to enhance their performance (Johansson & Klaesson, 2024).

The results of the power and sensitivity of dispersion analysis underscore the strength of the linkages between sectors within the national economic structure does not always reflect the absolute size of the sector's output contribution. The construction sector holds a strong backward linkage sector, demonstrating its primary role as a user of inputs in the production chain. On the other hand, the financial services and business services sectors are classified as strong forward linkage sectors, serving as important suppliers to other sectors. Although these

three sectors are not classified as key sectors (priority I), they still play a strategic role as drivers of input demand and providers of supporting services for cross-sectoral economic activity.

Multiplier Analysis

Output, income, and employment multipliers measure how a one-unit change in final demand affects total output, household income, and labor demand, respectively.

Table 3. Output, Income, and Employment Multipliers

Code	Sector	Output Multiplier	Income Multiplier	Employment Multiplier
1	Agriculture, Forestry, and Fisheries	1.2847	0.4713	0.0141
2	Mining and Quarrying	1.4985	0.384	0.0017
3	Manufacturing	1.7583	0.5602	0.0065
4	Electricity and Gas Supply	2.5076	0.5791	0.0019
5	Water Supply, Waste Management, and Recycling	1.5425	0.409	0.0277
6	Construction	1.7991	0.7386	0.0051
7	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	1.4343	0.5806	0.0086
8	Transportation and Warehousing	1.7841	0.6236	0.0055
9	Accomodation and Food Service Activities	1.8075	0.772	0.0145
10	Information and Communication	1.5862	0.4898	0.0022
11	Financial and Insurance Services	1.3243	0.4763	0.0024
12	Real Estate	1.3746	0.2338	0.0018
13	Business Services	1.6433	0.6307	0.0056
14	Public Administration, Defense, and Compulsory Social Security	1.7754	1.1356	0.0072
15	Education Services	1.4474	0.9535	0.0105
16	Health and Social Work Activities	1.9213	0.9028	0.0077

17	Other Services	1.6948	0.8056	0.0118

Source: Author(s)

Based on table 3, the electricity and gas supply sector in 2023 had the highest output multiplier of 2.5076, which was mainly driven by its own input of 1.5085 and input from mining and quarrying of 0.6711, reflecting concentrated input sources and increasing demand for mining products such as coal (Sajid et al., 2022; Takasago et al., 2024). On the other hand, the sector with the lowest output multiplier value is the agriculture, forestry, and fisheries sector, valued at 1.2847, given that this sector has weak backward linkages and tends to be independent in its production process. Compared to the average output multiplier of 1.6579, construction leads with 1.7991, business services are slightly below at 1.6433, and finance and insurance are lower at 1.3243, reflecting differences in their supply chain impacts (Marconi et al., 2016).

Education services have the highest income multiplier of 0.6805, boosting household income mainly within the sector due to its labor intensity (Kazekami, 2024; Yen et al., 2015). On the other hand, real estate has the lowest income multiplier of 0.2338 due to its capital-intensive nature, providing less household income from labor (Adrjan, 2018; Gao et al., 2024). Compared to the average income multiplier of 0.3824, construction is higher at 0.4036 due to its labor intensity, while business services are near the average at 0.3843. Finance and insurance have a lower income multiplier of 0.3603 due to capital-intensive displacement effects, highlighting differences in sectors' ability to boost household income (Acemoglu, 2025).

The water supply and waste management sector has the highest employment multiplier at 0.0277, creating the most jobs per 1 million increase in final demand due to its labor-intensive nature and the need for diverse skills in waste collection and recycling (Pomberger et al., 2021). In contrast, mining and quarrying had the lowest employment multiplier at 0.0017, reflecting limited job creation due to high mechanization and industrial automation (Brodny & Tutak, 2019). In terms of labor absorption, the three directly invested sectors had below-average employment multipliers of 0.0079, with business services at 0.0056 and construction at 0.0051, indicating limited effectiveness in creating jobs per unit of final demand despite construction being labor-intensive. Meanwhile, finance and insurance recorded the lowest employment multiplier at 0.0024, partly due to weak input suppliers and reliance on manufacturing, which also has low job creation from technological adoption and efficiency gains (Dai et al., 2022).

Based on the previous explanation, construction shows high output and income multipliers, driving intersectoral demand and household income. However, its job creation, like that of business and finance services, is below average, highlighting that investment impact varies across dimensions.

National Economic Impact Analysis

Table 4. Output, Income, and Employment Impact

Code	Sector	Shock (million IDR)	Output Changes (million IDR)	Income Changes (million IDR)	Employment Changes (person)
1	Agriculture, Forestry, and Fisheries	-	56,638	16,914	689
2	Mining and Quarrying	-	143,417	22,595	75
3	Manufacturing	-	165,285	25,547	408
4	Electricity and Gas Supply	-	16,452	824	6
5	Water Supply, Waste Management, and Recycling	-	110	17	3
6	Construction	795,214	811,159	192,921	1813
7	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	-	100,956	32,106	727
8	Transportation and Warehousing	-	69,907	13,318	187
9	Accommodation and Food Service Activities	-	3,766	897	37
10	Information and Communication	-	31,695	5,958	23
11	Financial and Insurance Services	59,812	90,652	25,748	135
12	Real Estate	-	8,477	605	6
13	Business Services	41,608	69,877	17,108	255

14	Public Administration, Defense, and Compulsory Social Security	-	2,194	1,047	10
15	Education Services	-	1,391	814	12
16	Health and Social Work Activities	-	606	161	2
17	Other Services	-	5,646	1,900	52
	Total	896,634	1,578,229	358,482	4,440

Source: Author(s)

Based on table 4, the Jalintim preservation project generated a total output of IDR 1,578,229 million or 1.76 times its investment value, with the largest contribution coming from the construction sector at IDR 811,159 million, and significant increases occurred in the processing industry sector at IDR 165,285 million, mining and quarrying at IDR 143,417 million, and wholesale and retail trade at IDR 100,956 million, reflecting strong inter-sectoral linkages.

These findings are consistent with the Keynesian multiplier mechanism, where investment shocks propagate through intersectoral demand linkages and stimulate aggregate production. Likewise, the observed backward linkages can be interpreted in light of Hirschman's unbalanced growth framework, suggesting that targeted infrastructure investment has the structural potential to induce activity in related sectors. However, these interpretations should be understood within the static accounting nature of the IO model, which captures structural relationships rather than dynamic behavioral responses. Although consistent in direction, the investment multiplier of 1.760 differs from previous studies, with 1.821 reported by Annisa et al. (2024), 1.520 by Tarassyta & Auwalin (2024), and 2.152 by Usman (2020), due to differences in IO tables, adjustment techniques, data accuracy, and sector classifications.

The study finds a similar pattern to Tarassyta & Auwalin (2024), with construction, manufacturing, and mining experiencing the largest output changes, as construction receives 88.69% of investment shocks from the South Sumatra Eastern Highway preservation project, creating a strong first-round effect. The investment shock effect is amplified by construction's position as a priority II sector with strong backward linkages, while the other two sectors, as priority III, have weaker backward linkages and less ability to draw output from other sectors.

As previously noted, construction ranks fourth in backward linkages above the national average, relying on manufacturing and mining as main input suppliers, with manufacturing providing metals, cement, and machinery and mining supplying construction materials, showing that highway preservation indirectly stimulates these sectors through high construction input demand. The strong backward linkages of finance and insurance and business services to manufacturing explain the significant output change in manufacturing because both sectors rely on manufacturing inputs, with finance and insurance requiring operational assets like computers, electronics, and vehicles, and business services needing technical equipment and goods for maintenance, so increased demand in these supporting services drives manufacturing output (Baker et al., 2015).

A final demand injection of IDR 896,634 million increased total household income across all sectors by IDR 358,482 million, yielding an income multiplier of 0.400, meaning that each IDR 1 million of investment is associated with an additional IDR 400 thousand in household income. The largest impact occurred in the construction sector (IDR 192,921 million), reflecting its dominant share in the investment allocation. The analysis also indicates indirect income effects in sectors not directly receiving investment, particularly wholesale and retail trade and vehicle repair (IDR 32,106 million), manufacturing (IDR 25,547 million), and mining and quarrying (IDR 22,595 million). These patterns are consistent with the Keynesian multiplier mechanism, while the presence of indirect spillovers can be interpreted through Hirschman's unbalanced growth framework. However, these interpretations should be understood within the static structure of the IO model, which represents fixed intersectoral relationships rather than dynamic economic adjustments.

The study shows that investment in the non-toll national road preservation project increases household income across all sectors, with an income multiplier of 0.400, compared to 0.281 as stated by Purnomo (2024), 0.311 as stated by Usman (2020), 0.294 as stated by Tarassyta & Auwalin (2024), and 0.363 as stated by Dwiatmoko et al. (2020). Differences arise from project type, labor compensation structures, IO table inputs, data accuracy, and sector classifications, even though the direction of impact is consistent.

An interesting finding of this study is the significant income spillover effect to sectors that do not receive direct investment. Empirical analysis shows that construction's main input suppliers are manufacturing, mining and quarrying, and wholesale and retail trade, so increased demand in construction generates additional household income through wages and business profits in these

supporting sectors, highlighting that investment in highly linked sectors creates both direct and widespread income effects.

Next, a final demand injection of IDR 896,634 million for the non-toll national road preservation project created a total of 4,440 new jobs across 17 sectors, meaning each IDR 1 billion of investment could employ 4.95 people, with the largest labor demand in construction at 1,813 workers, reflecting its status as the main investment recipient. Finance and business services directly created 135 and 255 jobs, while other sectors like trade, agriculture, and manufacturing also gained jobs, showing focused investment can generate employment across the economy.

These results suggest that road maintenance investment can be associated with broader employment effects through intersectoral linkages, a pattern that is consistent with Keynesian arguments that increased expenditure stimulates production and subsequently labor demand, as well as with Hirschman's view on sectoral inducement effects. However, this interpretation should be understood as an illustrative association derived from a static IO framework rather than a causal prediction of long-run economic dynamics.

The study confirms that infrastructure investment can create new jobs, finding 4.95 additional jobs per Rp1 billion invested, compared to 11.02 (Purnomo, 2024), 9.45 (Usman, 2020), 6.51 (Nasriyah & Aji, 2022), 2.52 (Tarassyta & Auwalin, 2024), and 9.55 (Dwiatmoko et al., 2020), with differences arising from IO tables, sector selection, project characteristics, and labor conditions. Besides directly impacted sectors, the largest job gains from the preservation project occurred in wholesale and retail trade, agriculture, forestry and fisheries, and manufacturing, driven by strong backward linkages, the emergence of MSMEs and large businesses, improved road infrastructure boosting distribution and production, and firms hiring more workers in anticipation of higher future productivity (Matusche, 2025; Yuan et al., 2024; Zahra et al., 2024).

The study reveals an interesting pattern that agriculture, forestry, and fisheries rank second in job creation, unlike sectors with the highest output and income gains such as manufacturing, trade, and mining, likely due to their labor-intensive nature and status as major employment sectors in Indonesia (Astuty, 2023). The characteristics of agriculture, forestry, and fisheries are reflected in its third-highest employment multiplier among 17 sectors, yet its output multiplier is the lowest, indicating that higher output and household income do not always coincide with greater job creation.

While the construction sector absorbs a significant volume of labor, the quality of this employment is often compromised by a prevalence of skill

mismatches, where local graduates lack specific technical competencies such as road and bridge construction (Bhattarai et al., 2025). Persistent gaps in occupation-specific skills may also encourage the substitution of domestic workers with foreign expertise (Akomolehin et al., 2025). To address this risk, vocational institutions must overhaul their curricula to deliver occupation-specific, modular competency-based training aligned with infrastructure sector demands, such as competencies in infrastructure logistics management and heavy machinery operation. Furthermore, simply mandating employment numbers is insufficient; preservation contracts must explicitly require the provision of high-quality On-the-Job Training (OJT), which has been shown to be a decisive factor in ensuring workers truly master subject matter knowledge (Bhattarai et al., 2025).

Regarding the induced impacts on the financial and trade sectors, realizing the full human capital potential requires a strategic shift from traditional administrative skills toward digital literacy and entrepreneurship. In the financial services sector, the rapid adoption of automation and big data analytics necessitates a curriculum reorientation that balances technical know-how with critical soft skills, such as leadership and collaboration, which are increasingly prioritized by employers (Said & Alhares, 2021). Simultaneously, to maximize economic spillovers in the informal trade sector, upskilling programs are essential to integrate informal workers into the formal supply chain and enhance their long-term productivity; otherwise, these spillovers risk remaining short-term and low-productivity in nature (Akomolehin et al., 2025).

Optimizing human capital in the business services and manufacturing supply chains requires a fundamental transition from reactive problem-solving to proactive development through collaborative frameworks. Implementing mechanisms such as Early Contractor Involvement (ECI) and joint risk management in preservation contracts facilitates early technical dialogue, allowing consultants, engineers, and contractors to co-create innovative solutions rather than merely responding to emergencies (Eriksson, 2019). This collaborative approach not only improves asset performance but also drives systemic innovation across infrastructure supply chains, including manufacturing actors, by encouraging the adoption of new materials and technologies that are often neglected under time-pressured, reactive maintenance regimes.

Overall, the IO analysis shows that investment in non-toll national road preservation generates wide-ranging national economic effects, with total output increasing by IDR 1,578,229 million, household income by IDR 358,482 million, and 4,440 new jobs created, while construction, as the main investment recipient, experiences the largest impact and finance, insurance, and business services record

relatively smaller effects. Although not directly receiving investment shocks, the largest economic impacts were concentrated in manufacturing and wholesale and retail trade, due to their strong backward linkages, highlighting that infrastructure development stimulates other sectors through complex economic connections.

However, this study acknowledges several methodological limitations inherent to the static Input-Output framework employed. First, the model assumes fixed technical coefficients and linear production functions, which fail to capture potential changes in technology, price fluctuations, or the substitution behavior of economic agents that may occur during the project's three-year implementation period. Second, the use of an aggregated 17-sector IO table, updated via the non-survey RAS method, may obscure specific sub-sectoral impacts and relies on the assumption that the estimated economic structure perfectly mirrors actual post-pandemic conditions. Lastly, the simulation treats the multi-year investment (2021–2023) as a single simultaneous shock within a one-year framework, thereby overlooking the dynamic temporal distribution of economic effects and potential crowding-out risks associated with large-scale resource mobilization.

To address these constraints and enhance the robustness of impact assessment, future research should consider adopting dynamic models such as Computable General Equilibrium (CGE) to capture non-linear responses, price mechanisms, and input substitution more realistically. Furthermore, subsequent studies are advised to utilize highly disaggregated IO tables (e.g., 52 or 185 sectors) and decompose the investment shock into an annual multi-period analysis to trace how economic effects evolve year by year. Improving the precision of sectoral shock allocation through data triangulation, particularly by incorporating field surveys or expert interviews, is also recommended to reduce aggregation bias and more accurately represent the actual expenditure patterns of preservation projects. Finally, extending the analysis to include long-term welfare effects would provide a more holistic view of the project's contribution to sustainable development.

5. Conclusion

This study demonstrates that the South Sumatra Eastern Highway preservation project does more than maintain physical assets, as it activates a diverse set of economic engines with distinct roles. The analysis highlights a clear structural contrast where the construction sector primarily drives growth by ‘pulling’ demand from upstream suppliers. In contrast, financial and business services operate by ‘pushing’ supply to support downstream industries. This distinction is critical because it proves that road preservation creates a dual impact. It combines the immediate, high-demand effects of physical construction with the

strategic support of the service sector to create a balanced mechanism for intersectoral productivity and continuous growth.

In quantitative terms, the investment of Rp896,634 million yields a significant return for the national economy. The project generates a total output of Rp1,578,229 million, representing a multiplier of 1.76, and this figure validates the high economic value of preservation efforts. Crucially, these benefits extend well beyond the preservation work itself. The investment triggers spillover effects in manufacturing, mining, and trade, and it boosts household income by Rp358,482 million. Furthermore, the project creates 4,440 new jobs distributed across construction, agriculture, and retail, demonstrating its capacity to serve as an effective tool for equitable income distribution and resilient job creation.

6. Policy Recommendation

Based on the empirical IO results, which show that the preservation project generates the strongest employment and output impacts in construction and its upstream manufacturing supply chains, several concrete policy actions can be proposed for public authorities. First, government agencies should prioritize strengthening domestic manufacturing as a key supplier to construction by implementing targeted fiscal incentives, simplifying licensing procedures, and coordinating logistics improvements. The strong backward linkages identified in the analysis indicate that expanding domestic production capacity in construction-related manufacturing is essential for maximizing economy-wide spillover benefits.

Second, the IO findings reveal significant induced effects in financial and business services, underscoring the need for coordinated public investment in the supporting institutional ecosystem. Policymakers should reinforce the information and communication sector through digital infrastructure programs and innovation incentives, ensuring that the growth of service sectors enhances administrative efficiency, financial management, and long-term asset governance rather than merely expanding transactional activities.

Third, since the employment multipliers are concentrated in sectors requiring both technical and service-oriented competencies, public institutions should position human capital development as a central component of infrastructure policy. This includes reforming vocational education curricula, establishing formal partnerships between training institutions and industry, and mandating targeted skills programs aligned with the sectoral labor demands identified in the empirical analysis, particularly in construction, manufacturing support activities, and business services.

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