The Economic Impact: A Case Study of Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project

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Abstract

The research aims to 1) analyze the economic linkages of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project and 2) evaluate the economic impacts of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project. This research will be conducted quantitatively, analyzing the production factors and outputs that have been further improved in the construction sector of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project. These will be incorporated into the production and output tables. The research findings indicate the following: 1) The backward multipliers of the intercity expressway project mentioned have higher values than the forward multipliers. This demonstrates that the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project has a greater impact on connecting with other industries in the upstream sector. 2) The Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project has resulted in an overall increase of 0.319% in the country's gross domestic product (GDP) compared to the baseline case, which is equivalent to a value of 44,368.03 million baht. The top 10 industries that experienced the highest increase in production output include mining and quarrying, the production of metal–based furniture and fixtures, engine and turbine manufacturing, cutting tool manufacturing, general–purpose machinery and equipment manufacturing using steel, cement production, petroleum and natural gas extraction, land transport of goods, business services, electricity generation, concrete product manufacturing, and job creation.

Keywords: Economic Impact; Motorway Project; Forward–Backward Multipliers; Input–Output Analysis

Introduction

The development of transportation infrastructure is a crucial factor in economic growth. Infrastructure development in transportation and economic growth are interconnected and mutually reinforcing. It leads to the expansion of the manufacturing sector, job creation, and overall economic growth. Transportation plays a primary role in building sustainability and enhances the production capacity of a country by adding value to its existing resources (Raghuram & Babu, 2001). The development of transportation infrastructure in Thailand, including roads, railways, ports, waterways, and airports, is a key focus of development. It serves as a vital mechanism for economic growth. Efficient and effective infrastructure development is a significant factor in enhancing competitiveness and increasing the potential for economic expansion.

Policy investment in infrastructure development is a crucial aspect of Thailand's economic and social development plan, the 12th National Economic and Social Development Plan (BE 2017–2026), spanning a period of 10 years. The plan emphasizes the need for investment in infrastructure, with a total investment budget of approximately 3.099 trillion baht. Specifically, the plan focuses on transportation infrastructure investment, which accounts for approximately 56.13% of the total investment.

The development plan for transportation infrastructure in Thailand gives priority to road transportation, with an estimated investment expenditure for projects under the 12th National Economic and Social Development Plan (BE 2017–2026) amounting to 254.04 billion baht. This represents 71.69% of the total road network development (Office of the National Economic and Social Development Council, 2020). The development of urban expressway projects aims to enhance competitiveness, stimulate economic activities, generate added value, improve productivity in the manufacturing and service sectors, and reduce production and service costs to compete globally.

The Bang Pa–In–Nakhon Ratchasima Expressway, also known as Motorway Route M6, is a significant project that is deemed urgent among the five projects included in the Action Plan for Accelerating Investment by the Ministry of Transport. It has been included in the infrastructure development plan for road transportation and the Public–Private Partnership (PPP) Fast Track program by the Ministry of Finance to expedite large–scale investment projects efficiently. The estimated investment expenditure for this project is 84.6 billion baht, accounting for 30.1% of the total investment for the entire expressway development project.

This expressway will serve as a crucial link between Bangkok and the central region of northeastern Thailand. It will significantly reduce the distance, covering a span of 196 kilometers with a travel time of just 127 minutes. Additionally, it will also serve as a connection to neighboring countries such as Laos, Vietnam, Cambodia, and southern China. The initial route will start at the intersection with the outer ring road and Phahonyothin Road near Bang Pa–In in Ayutthaya province, run parallel to Phahonyothin Road and Mitraparp Road, and converge with the bypass road in Nakhon Ratchasima province at Kilometer 2 (Department of Highways, 2021).

The method of assessing impacts to understand the structure of economic growth requires the application of economic data combined with Ridwan et al. (2015) theory. The study examines the evaluation of economic benefits from new infrastructure investments and the environmental benefits derived from the production sector (key sector) resulting from the reduction in transportation costs. It analyzes the impacts and linkages between sectors and estimates the Gross Domestic Product (GDP) by finding the production factor coefficients and analyzing backward linkage multipliers (backward linkages) and forward linkage multipliers (forward linkages). It is found that investment in road infrastructure has a positive impact on the production sector in terms of reducing transportation costs (distribution costs), benefiting both the production sector and the overall economy. This helps enhance the economic efficiency of the region. By reducing transportation costs for moving goods from cities to regions. Emphasizing new transportation investments, it is found that such investments lead to changes in transportation costs for businesses, affecting the price levels of products in various sectors, and expanding existing industries due to changes in final demand. The reduction in business costs and changes in business demand for transportation services are stimulated by new transportation investments, promoting diverse transportation service demands. This supports the idea of investing in infrastructure due to its impact on economic growth (Jian and Michael, 2010).

The development of transportation infrastructure has an impact on economic growth and is essential to achieving the goals of increasing capacity and competitiveness in a highly efficient logistics country. The Bang Pa–in–Nakhon Ratchasima motorway project is a critical and urgent project with the highest priority, connecting Bangkok to the northeastern region, which experiences high travel volume and requires significant investment. To assess the efficiency of the government's decision–making regarding this investment project, it is necessary to evaluate whether it is more effective for public funds to be allocated to other projects and how the infrastructure investment,

when considered as a project within a series of projects, impacts the economy. This leads to the need to assess the economic impacts, analyze the linkages between sectors, and estimate the economic forecast using an input–output table. By finding the production factor coefficients and analyzing backward and forward linkage multipliers, the impacts on the production sector can be determined, providing clear conclusions on the direction and significant impacts of public sector spending resulting from investment in the Bang Pa–in–Nakhon Ratchasima motorway project. This enables the effective formulation of transportation infrastructure investment policies that address specific sectoral issues and provide efficient support before or after implementation.

Research Objectives

1. To analyze the economic linkages of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project.

2. To assess the economic impacts of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project.

Research Scope

Content Scope

The research scope includes analyzing the linkages between sectors in the supply chain and the economic impacts of the construction sector on the national economy, specifically for the expressway project between Bang Pa–In and Nakhon Ratchasima and its linkages with other production sectors in the country. The analysis utilizes the Input–Output Table data set of the year 2015, which is the latest published version, with a matrix size of 180 x 180 representing economic sectors. Additionally, construction project budgets are added to the table under sector code 141, which represents the production of non–agricultural public service activities. The Leontief Multiplier is applied to determine the factor income multipliers of direct and indirect production and to calculate the backward linkage multiplier and forward linkage multiplier, which analyze the backward and forward linkages, respectively.

Area Scope: The study covered the project area in 3 provinces: Phra Nakhon Si Ayutthaya, Saraburi and Nakhon Ratchasima.

Timing Scope: The study was conducted during the years 2015 – 2022, before and after the construction of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project.

Literature Review

1. To analyze the economic linkages of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project.

In studying the development of transportation infrastructure, transportation plays a crucial role in expanding the manufacturing sector, employment opportunities, and fostering economic growth. Transportation serves as a primary facilitator in sustainable development, particularly in supporting long–term progress. Starting from transportation infrastructure, it directly and efficiently contributes to the production process, becoming a vital link to accessing various transportation options that are increasingly available. (Pradhan & Bagchi, 2013) Well–designed road transportation can help reduce the time it takes to deliver goods to the market and decrease transportation costs within the production process.

In studying the development of transportation infrastructure, transportation plays a crucial role in expanding the manufacturing sector, creating employment opportunities, and fostering economic growth. Transportation serves as a primary facilitator in sustainable development, particularly in supporting long–term progress. Starting with transportation infrastructure, it directly and efficiently contributes to the production process, becoming a vital link to accessing various transportation options that are increasingly available. (Pradhan & Bagchi, 2013) Well–designed road transportation can help reduce the time it takes to deliver goods to the market and decrease transportation costs within the production process.This infrastructure can act as the backbone for economic growth in the region (Gramlich, 1994; Ramanathan & Parikh, 1999). Consequently, studies have examined the economic impacts resulting from infrastructure development in various aspects. For example, Ridwan et al. (2015) assessed the broader economic benefits of investing in the new infrastructure of the Cipularang Toll Road in the Bandung region, which has a significant connection with the tollway. They particularly focused on the indirect benefits derived from the manufacturing sector, resulting from decreased transportation costs. The table of production factors and outputs (input–output analysis) at the regional level serves as a foundation for macroeconomic planning and analysis, particularly regarding the manufacturing sector, the analysis of impacts, the interlinkages

between sectors, and the estimation of gross domestic product (GDP). The study of backward and forward linkage multipliers indicates that investments in road infrastructure in each sector of the manufacturing industry, in terms of reducing transportation costs (distribution costs), have positive effects on the manufacturing sector and the macroeconomic economy.

It helps enhance the economic efficiency of the region by reducing transportation costs associated with the movement of goods between cities or regions. The multiplier effect of the industrial sector's output value increases when the cost decreases by 10%. If the cost is reduced by 10%, it results in a 76.975 million baht increase in the Gross Domestic Product (GDP) overall. Given the current economic conditions, including issues such as the spread of viruses, environmental concerns, and financial problems, there are debates about the effectiveness of investments in recovery and infrastructure construction for transportation. The question is whether these investments are more efficient or provide better use of public funds compared to other projects. To ensure that public capital investments have the maximum positive impact, the government needs to find methods to evaluate the economic benefits arising from transportation infrastructure projects. This is crucial to ensuring that these projects are sufficiently justified for investment in economic development.

2. To assess the economic impacts of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project.

In studying the economic impacts of transportation infrastructure, Jian and Michael (2010) conducted an economic impact assessment of infrastructure investments in road, rail, water, and air transportation in Australia. They used input–output analysis for the years 2007–2008, considering a total of 30 sectors. The analysis aimed to examine the economic impacts of transportation investments, which varied across sectors. Two methods were used to analyze the impacts: price analysis (changes in value–added or prices per unit of output of a particular industry) and quantity analysis (changes in the final demand of a particular industry) to respond to the sources of economic changes that may occur within the economic system. The focus was on new transportation investments, which led to changes in transportation costs for businesses and affected the price levels of various sectors and existing industries due to changes in final demand. The study supported the idea that investing in infrastructure has an impact on the economic growth of the transportation sector. Dwiatmoko et al. (2020) examined the role of rail transportation and other sectors in the Indonesian economy from 2000 to 2010. They utilized input–output analysis with a total of 161

sectors to provide policymakers with a fundamental understanding of the role of rail transportation compared to other sectors. The analysis assessed the contribution of each transportation sector to the overall production of the transportation sector. It analyzed the interlinkages between different sectors and the multiplier effects of each transportation sector on production, income, and employment. The study reflected that road transportation had the highest contribution, with 38.19% in 2010, increasing to 52.12% in 2011. Sea transportation ranked second with a contribution of 11.62%. The initial increase in air transportation was due to the convenience and affordability of low–cost airlines, making air transportation a preferred choice for the public. On the other hand, rail transportation had the lowest contribution with only 1.15% when compared to other modes of transportation. The results of the employment multiplier calculations for the transportation sector showed that an increase in rail transportation demand by 1 billion rupiahs would have an impact on employment opportunities in the sector, generating approximately 9.556 billion jobs. Without the interrelationship between sectors, employment opportunities would increase to 7.254 billion jobs. This demonstrates the ability to assess the economic impact on production, income, and employment. Furthermore, it also reflects the linkages between infrastructure development and economic growth in the same direction.

The analysis using an input–output table demonstrates that economic data can reveal the interrelationships between sectors and the connections among various sectors within the economic system. These linkages can take different forms, including the value of economic activities and the flow of transactions within the business system.

Research Methodology

The study aims to analyze the economic impacts of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project, which is a quantitative study (quantitative method) using secondary data. The researcher proceeded with the following steps:

1) Tools used in the study

The operations carried out in the aforementioned research project focus on studying quantitative analysis methods, utilizing an input–output table for the year 2015 in Thailand. This table includes additional branches related to the construction of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project, with the steps to proceed as follows:

Step 1: The gathering of geographical data from various sources to enhance the current production and productivity factors as well as reflect the structure of the Thai economy in 2022 will be conducted in this research study. The study will utilize geographical data from different sources, including: 1) the Input–Output Table of the Year 2015, which is the most recent version compiled and published by the National Economic and Social Development Council (NESDC); 2) The national income accounting data of Thailand for the year 2022, 3) Financial data of corporate entities involved in construction projects in the year 2022, obtained from the Business Data Warehouse system of the Department of Business Development, Ministry of Commerce, 4) Export and import data at the product level for the year 2022, provided by the Customs Department, 5) Production data and sales volume of goods within the country at the product level for the year 2022, from the Office of Industrial Economics, 6) Other miscellaneous data, including the Labor Force Survey of the Year 2022, conducted by the National Statistical Office, and various tax–related data for the year 2022.

Step 2: The process of updating Thailand's input–output (I/O) table of production and output factors from 2015, as well as reflecting the economic structure in 2022, involves utilizing the aforementioned collected geographic data. This is done to improve the current I/O table of production and output factors for Thailand. For example, data from Thailand's National Accounts for the year 2022 is used to update the economic value, value added, and final demand data to the present time, both at an aggregate level and at a sectoral level of production. Additionally, data from the Economic and Social Survey of Households in the year 2022 is utilized as a basis for income and expenditure information regarding Thai households.

Step 3: Addition to the branches of production, construction, and public service not related to agriculture This branch includes the construction and repair of highways, roads, bridges, ports, airports, railway stations, main water pipes, and sewage systems, among others. The branch code is 141, and it is included in the I/O Table. The vertical (column) data represents the structure of production and the use of production factors in the form of intermediate inputs and primary inputs. The horizontal (row) data represents the structure of the distribution of production to intermediate demand and final demand in the construction of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project.

Step 4: Data processing and calculation/calibration of the updated and expanded I/O Table for the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project

Step 5: A balancing table is prepared using the RAS method due to the additional branch of the construction project for the Bangkok–Pak Kret to Nakhon Ratchasima expressway in the I/O table. This results in an imbalance in the total data in the columns and rows. Therefore, it is necessary to balance the table using the RAS method, which involves creating a new matrix when new aggregate values occur while maintaining the same structure of the various elements as the original matrix (Miller & Blair, 2009).

2) Data collection

The researcher used the method of collecting data from the Input–Output Table for the year 2015, which was recently updated and revised by the National Economic and Social Development Board (NESDB). The data included 180 production activities and budget estimates for the construction of the Bangkok–Pak Kret to Nakhon Ratchasima expressway, consisting of 40 contracts. The data also included Gross Domestic Product (GDP) and Gross Provincial Product (GPP), which comprised important sub–data such as household consumption expenditure, government expenditure, investment value, inventory value, and export–import value. The data was collected from various agencies, including the NESDB, the National Statistical Office, and the Board of Investment.

3) Data analysis

The researcher conducted the analysis using the Input–Output Table for the year 2015 and the budget estimates for the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project. The analysis was divided into two parts, as follows:

1.1 Analysis of production factor usage structure

The analysis of the production factor usage structure is conducted by extracting data along the vertical column of the input–output table. This data is used to calculate the direct factor productivity coefficients (AIJ), which reveal the production structure of a specific sector of the economy. It provides information on how the production of sector j utilizes intermediate factors of production from domestic production and the use of primary factors of production (value–added) from sector i in what proportions.

1.2 Analysis of production distribution structure:

The analysis of the production distribution structure is conducted by examining the data horizontally (row) in Sector I of the Input–Output Table for production factors and outputs. In the

transaction table, it is used to calculate the proportions between the value of production for each sector of the economy (Xij) and the total value of production (Xi). This analysis reveals how the outputs of each sector of the economy are distributed among different groups of consumers. (Leontief, 1986)

1.3 Economic linkages

Economic linkages can be divided into two types: direct backward linkages and direct forward linkages. Direct backward linkages provide information about the structure of production factor usage in a particular sector of the economy, indicating the extent to which it relies on production factors from various other sectors. The calculation of direct backward linkages for sector j is derived from the total sum of all intermediate factors of production used in sector j, divided by the total sum of the outputs of sector j.

$$U_j = \frac{\Sigma_j^n X_{ij}}{X_j} \quad \text{หรือ} \quad U_j = \Sigma_j^n a_{jj}$$

Alternatively, direct backward linkages can be represented by the sum of the direct factor productivity coefficients (aij). Direct forward linkages, on the other hand, provide information about the distribution structure of the construction project's outputs to other sectors of the economy, indicating the proportion of these outputs used as factors of production. The calculation of direct forward linkages for sector i is derived from the total sum of all intermediate outputs used as factors of production in sector i, divided by the total sum of the economic sector's output.

$$U_j = \frac{\Sigma_j^n X_{ij}}{X_j}$$

Where:

X_j = the output of sector j.

X_j = the output of sector i.

$\Sigma_j X_{ij}$ = the total sum of direct factor inputs used by sector j.

$\Sigma_i X_{ij}$ = the total sum of the output of sector i used as factor inputs in other sectors of production.

n= the total number of sectors in the economy.

The higher the calculated values of U_j and U_i, the stronger the interdependence between the respective sector and other sectors in direct or indirect terms. Conversely, if the calculated values of U_j and U_i are lower, it indicates a lower level of linkage with the other sectors of the economy.

The Direct and Indirect Linkage Effect

The Direct and Indirect Linkage Effect is an index that indicates the overall level of continuous direct and indirect impacts on the ultimate objective change of an economic sector. It refers to the extent to which a change in one sector affects the production level of other sectors of the economy, both as a factor supplier and a factor purchaser, using the matrix of direct and indirect coefficient of production (matrix $1 - \mathrm{A}^{-1}$). The analysis of this effect is divided into two parts:

The Backward Linkages Index is an index that reflects the backward impact of expansion in an economic sector on the overall economy. It represents the effect of the demand for intermediate goods in other production sectors, which leads to an increase in production in those sectors (Wangkahat, 2009).

$$a_j = \frac{\Sigma_i b_{ij}}{\frac{1}{n}\Sigma_i \Sigma_j b_{ij}} \quad (\mathrm{I} = \mathrm{j} = 1,2,\ldots..,\mathrm{n})$$

The Forward Linkages Index is an index that indicates the distribution of output from one production sector to various other production sectors.

$$\beta_j = \frac{\Sigma_i b_{ij}}{\frac{1}{n}\Sigma_i \Sigma_j b_{ij}} \quad (\mathrm{I} = \mathrm{j} = 1,2,\ldots..,\mathrm{n})$$

Where:

A = Input–output coefficient matrix

I = Identity matrix

a_j = Backward Linkages Index

β_j = Direct intermediate inputs used by sector j

$\Sigma_i b_j$ = Sum of horizontal elements of the matrix

$\Sigma_i b_{ij}$ = Sum of off–diagonal elements of the matrix

$\Sigma_j \Sigma_i b_{ij}$ = Sum of all off–diagonal elements of the matrix

$\Sigma_i \Sigma_j b_{ij}$ = Sum of all vertical elements of the matrix

n = Total number of production sectors in the matrix

It should be noted that the average value of the overall linkage index is 1. Therefore, if an economic sector or production sector has a total linkage index value greater than 1, it means that the linkage value for that sector is higher than the average value of all production sectors.

2. Economic Multiplier Analysis

In economic multiplier analysis, it is necessary to know the direct and indirect coefficients of production factors in order to perform the calculations. These coefficients can be obtained through the multiplication of the identity matrix (matrix I) and the matrix of production factor coefficients within the country (matrix A).

From X = AX+F

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

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

By defining

the matrix $I - A^{-1}$

as matrix B which

$$B_{ij} = \begin{bmatrix} b_{11} & b_{12\ldots} & b_{1n} \\ b_{21} & b_{22\ldots} & b_{2n} \\ \vdots & \vdots & \vdots \\ b_{n1} & b_{n2\ldots} & b_{mm} \end{bmatrix}$$

X can be represented as q, and the equation can be written as:

q = B F

The matrix $I - A^{-1}$ or matrix B is referred to as the direct and indirect coefficient of production factors or Leontief's Domestic Matrix. It explains that when the final demand of economic sector j changes by 1%, it will cause changes in production in both the direct and indirect sectors according to the direct and indirect coefficient of production factors, which are represented as bij percentages (Leontief, 1936)

Result

Analysis of the economic linkages the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project. The results of the research revealed that:

The production structure of the expressway project shows that the investment in construction utilizes intermediate production factors worth 231,485,989 baht, accounting for 69.83% of the total production cost. The intermediate production factors include domestically produced inputs and the value added, which amounts to 100,010,700 baht, representing 30.17% of the total production cost. Breaking down the intermediate production factors, they consist of wages, salaries, and employee compensation, accounting for 32.22%, operating surplus at 41.60%, depreciation costs at 21.97%, and net indirect taxes at 4.21%. The key intermediate production factors used in the construction of the Bang Pa–in–Nakhon Ratchasima Expressway project include concrete production (21.39%), mining and quarrying (20.13%), steel production (14.73%), cement production (11.03%), and land transport of goods (7.06%).

The production structure of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project reveals that there is a production structure for distributing the final demand in terms of total expenditure for investment, amounting to 331,496,689.00 baht. This is because the construction of the expressway project is an investment in the construction of public service facilities for national development.

The analysis of direct and indirect production and output coefficients (direct and indirect coefficients) from Thailand in the 2015 Input–Output Table, which consists of 180 production sectors, reveals that the production sector of constructing the expressway project, Bang Pa–In–Nakhon Ratchasima, has 10 initial outputs. These outputs include mining and quarrying. The coefficient value for this sector is 0.1711, indicating that for every 1 Baht of expansion in the construction of the expressway project, it will result in a 0.1711 Baht increase in the expansion of the mining and quarrying sector.

The next sector is the production of concrete products. The coefficient value for this sector is 0.1511. Finally, the sector of steel product manufacturing has a coefficient value of 0.1428. The cement production sector has a coefficient value of 0.1171. And the utilization of factors from petroleum products, namely the petroleum refinery, with a coefficient value of 0.1007. The production of petroleum and natural gas products, with a coefficient value of 0.0867. Other products

derived from petroleum include products like petroleum jelly, engine oil, paraffin, carbon black, compressed charcoal, and tar, with a coefficient value of 0.0325. Additionally, factors from the service sector are also utilized, such as land transportation services, with a coefficient value of 0.0514. Business services coefficient value for this sector is 0.0381. This category also includes the electricity sector, with a coefficient value of 0.0344, as shown in Table 1.

Table 1: Direct Coefficient of Production Factors for the Top 10 Branches Used in the Construction of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project

No.	Production field	Coefficient
1	Quarrying and rock crushing	0.1711
2	Production of concrete products	0.1511
3	Production of steel products	0.1428
4	Cement production	0.1171
5	Petroleum Refinery	0.1007
6	Petroleum and natural gas production	0.0867
7	Land transport	0.0514
8	Business service	0.0381
9	Electricity	0.0344
10	Production of other products from petroleum	0.0325

Source: Calculation by the researcher.

The analysis of the linkages of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project with other production branches reveals that the backward multipliers of the intercity expressway project have a value of 2.54, which is higher than the value of the forward multipliers, which is 1.00. This indicates that the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project has a greater impact on the connections with other industries in the supply chain. Therefore, the position of the intercity expressway project between Bang Pa–In and Nakhon Ratchasima in the supply chain is located at the end of the production process, close to the delivery to consumers. The backward multipliers of the project are also higher than the average forward multipliers of all industries, which is 1.85. In addition, the forward multipliers of the intercity expressway project have a value of 1.00, which are lower than the average forward multipliers of all industries. This shows that the expansion or increase in the construction of the intercity expressway project will

have an impact on the intermediate goods or demand for products used as factors in increased production. as shown in Figure 1.

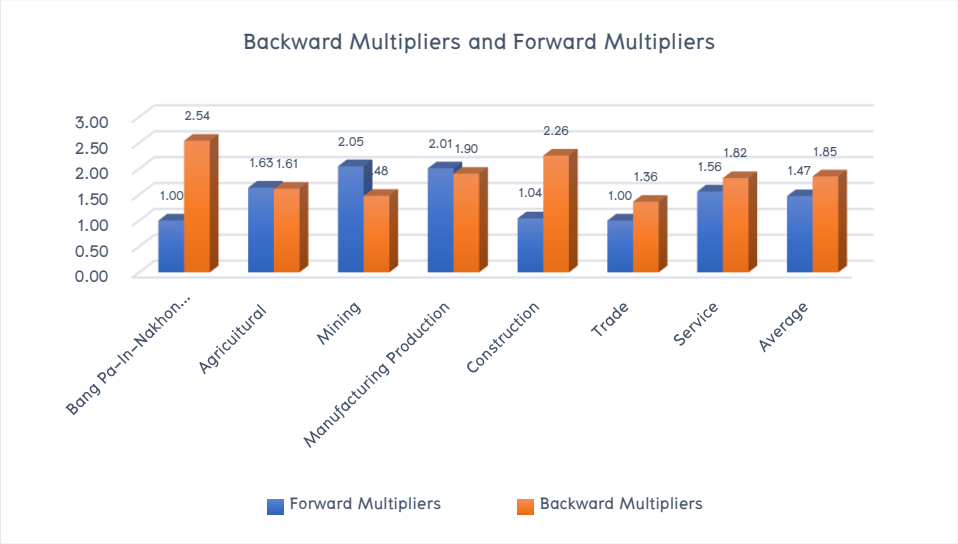

Figure 1 Comparison of Backward Multipliers and Forward Multipliers.

Source: Calculation by the researcher.

Furthermore, when analyzing the supply chain of the construction industry, which includes public service construction projects unrelated to agriculture such as road construction and repairs, bridges, ports, airports, and railway stations, it is found that there are significant connections with other industries. Starting from material manufacturers and suppliers for construction projects, including structural materials such as concrete, cement, steel, and iron, and reinforcement bars, as well as systems such as electrical, plumbing, and communication systems, and finishing works such as glass, doors, and windows, which fall under the category of primary industries. It is also related to intermediate industries, such as the production of construction tools and equipment, as well as the production of machinery and electrical equipment for industrial purposes. Finally, it extends to downstream industries such as real estate companies and various service sectors, including land transportation, financial institutions, restaurants and beverage shops, and hotel accommodations.

Economic Impact Assessment: Case Study of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project. The research findings on the economic impact assessment of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project indicate that the project has had a

positive effect on the country's Gross Domestic Product (GDP). The overall GDP has increased by 0.319 percent, equivalent to a value of 44,368.03 million baht, when compared to the baseline scenario. When considering the individual industries, the following top 10 industries experienced the highest increase in production volume as a result of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project: Mining and quarrying: The value of production increased by 11,012.80 million baht. Manufacture of fabricated metal products, except machinery and equipment: the value of production increased by 9,728.35 million baht. Manufacture of motor vehicles, trailers, and semi–trailers: the value of production increased by 9,194.52 million baht. Manufacture of machinery and equipment: The value of production increased by 7,540.72 million baht. Manufacture of cement: The value of production increased by 6,484.61 million baht, Extraction of petroleum and natural gas: The value of production increased by 5,583.18 million baht, Land transport: The value of production increased by 3,306.81 million baht, Business services: The value of production increased by 2,455.09 million baht, Electricity: The value of production increased by 2,213.76 million baht. Manufacture of concrete products:

The value of production increased by 2,095.26 million baht. In addition to that, the expressway project between Bang Pa–in and Nakhon Ratchasima has also had an impact on employment, resulting in a 0.293 percent increase in employment or an estimated value of 14,033.25 million baht. When comparing the total value of national employment, it is evident that this infrastructure construction project has contributed to the improvement of the economy, both in terms of increased production and employment and the ability to link the distribution of production to other industries. as shown in Table 2.

Table 2: Table of Economic Impact Assessment for the Case of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project

Production field	Increased output value (million baht)
Stone Quarrying	11,012.80
Furniture and Fixtures Metal	9,728.35
Engines and Turbines	9,194.52
Cutlery and Hand Tools	7,540.72
Cement	6,484.61
Petroleum and Natural Gas	5,583.18
Road Freight Transport	3,306.81
Business Service	2,455.09
Electricity	2,213.76
Concrete and Cement Products	2,095.26
Change in Gross Domestic Product	44,368.03
Change in Total Wage	14,033.25

Source: Calculation by the researcher.

Discussion

The results of the analysis on the economic linkages of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project indicate that the construction investment in the project primarily relies on the use of intermediate inputs. The most significant intermediate inputs used in the construction of the expressway project within the country are the production of concrete, quarrying and crushing of stones, production of steel products, cement production, land transportation of goods, and the structure of the distribution of project outputs. It is found that there is a structure for distributing project outputs to meet the final demand in terms of investment expenditure. This is because the construction of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project is an investment in the construction of public infrastructure for national development. same as Varnavskii (2021), who assessed structural changes and stability in the Russian transport sector. It was found that the share of intermediate goods and services in the total output of the transport sector decreased, while the share of final goods increases. It shows that the transport sector is a very important industry for Russia. In 2000–2014, the Russian economy grew rapidly due to the continuous increase in the transport system in sectors such as land transport, warehousing, and transportation support activities, which affected the growth of yield during the same period.

The analysis of the backward multipliers and forward multipliers of the Bangkok–Inn City–Nakhon Ratchasima Expressway project reveals that the backward multipliers are higher than the forward multipliers. This indicates that the expressway project has a greater impact on the connection with other industries in the supply chain, such as concrete production, mining and quarrying, steel production, cement production, and land transportation. Therefore, the position of the Bangkok–Inn City–Nakhon Ratchasima Expressway project in the supply chain is located at the end of the production process, close to the delivery to consumers. This finding aligns with Bing, Nuo, and Yixuan (2022), which investigate the role of various transportation modes in China's economy. They found that the transportation industry in the industrial supply chain indicates that road transportation is more strongly linked to forward linkages than backward linkages. This suggests that China's transportation industry, particularly road transportation, functions more as a user of upstream industries' outputs, such as petroleum products and coal, than a supplier of production factors to downstream industries. Specifically, the transportation industry is considered a service provider in the supply chain, along with finance and insurance. This is because road transportation has a high proportion of domestic cargo transportation.

The results from the assessment of the economic impact of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project indicate that the project has contributed to an overall increase in the Gross Domestic Product (GDP) within the country. When considering industries individually, the following top 10 industries experienced the highest increase in production quantity as a result of the project: mining and quarrying, production of metal–based furniture and fixtures, manufacturing of engines and turbines, production of cutting tools, iron and steel–based tools and appliances, cement production, petroleum and natural gas production, land transportation of goods, business services, and electricity generation. And the project has also led to an increase in the production of concrete products. In addition, the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project has also had an impact on employment, leading to an increase in job opportunities. This demonstrates that infrastructure projects, such as highway construction, not only contribute to increased production but also lead to job creation and facilitate the distribution of production to other industries. Expressways, or motorways, play a significant role in shaping the economy, space, and society. Improved accessibility resulting from increased access has implications for economic and social opportunities for people (Niemeier, 1997).The impacts of increased accessibility on economic growth, land use patterns, and property prices reflect diverse outcomes in terms of transportation

infrastructure types, property types, study areas, and levels of national development (Elburz et al., 2017). Consistent with the study by Bing, Nuo, and Yixuan (2022), it was found that the transportation industry stimulates employment, as seen in the employment generated by China's transportation.

When investment policies are established and transportation projects are selected, the government can efficiently develop projects that create more employment opportunities. Therefore, understanding the economic support and development of various transportation industries can help the government formulate policies to promote the balanced and integrated development of different transportation modes. Road transport, being the most robust mode of transportation, should be given importance, and challenges that hinder economic development should be addressed. It has the highest backward linkage and multiplier effects, contributing to relatively large–scale production, meaning the ability to promote the growth of the upstream industry is relatively strong.

Conclusion

The economic linkages of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project

The Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project indicates that the construction investment in the project primarily relies on the use of intermediate inputs. The most significant intermediate inputs used in the construction of the expressway project within the country are the production of concrete, quarrying and crushing of stones, production of steel products, cement production, land transportation of goods, and the structure of the distribution of project outputs. It is found that there is a structure for distributing project outputs to meet the final demand in terms of investment expenditure. And the backward multipliers are higher than the forward multipliers. This indicates that the expressway project has a greater impact on the connection with other industries in the supply chain. Therefore, the position of the Bangkok–Inn City–Nakhon Ratchasima Expressway project in the supply chain is located at the end of the production process, close to the delivery to consumers.

The economic impact of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project

The construction of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project has resulted in the connectivity of industrial sectors involved in construction and various manufacturing sectors. This has led to economic growth, increased employment opportunities, and added value to the service sector. Overall, the expressway project has contributed to economic development and growth. The project has contributed to an overall increase in GDP of 0.319 percent, equivalent to a value of 44,368.03 million baht, resulting in a 0.293 percent increase in employment or an estimated value of 14,033.25 million baht.

Suggestion

From the research results, the researcher has the following suggestions:

1. Suggestions from the research

The analysis of the linkages between the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project reflects the role of the transportation industry in the industrial supply chain. The government should be aware of the relevant industries in the upstream and downstream of the transportation sector. Planning and policy formulation should promote the development of industrial clusters that are important for the country's economic development. Analyzing and comparing the linkages between various sectors in the industrial supply chain can help identify the relevant industries. The government should plan investment in the development of industries such as mining and quarrying, production of metal–based furniture and fixtures, engine and turbine manufacturing, cutting tool production, general–purpose machinery and equipment made of steel, cement production, petroleum and natural gas production, land transportation of goods, business services, electricity, and concrete product manufacturing. Developing these sectors can facilitate cost management in construction projects related to the expressway or production costs in the transportation industry.

The impact assessment of the Bang Pa–In–Nakhon Ratchasima Intercity Motorway Project indicates that it has led to increased domestic production and employment. Therefore, the government should prioritize budget allocation for construction without increasing the budget and ensure timely completion of the project according to the construction contract. Failure to do so could

have an adverse impact on economic development. The government should invest in training transportation experts to assess cost–benefit analyses and formulate investment plans and selection criteria for constructing city–to–city expressway projects that have positive effects on the economy and increase value–added and productivity. These projects create employment opportunities that enhance the quality of life for the population and serve as a means to connect economic growth from cities to regions.

2. Suggestions for Future Research

Additional suggestions from the research study include studying the economic impact of other expressway projects in addition to the Bang Pa–In to Nakhon Ratchasima expressway. This particular project is just one of the 13 city–to–city expressway routes. Future studies should consider examining other routes such as the Bang Yai–Kanchanaburi expressway, the Pattaya–Maptaphut expressway, the Nakhon Pathom–Cha–am expressway, and the Bang Pa–In–Nakhon Sawan expressway, among others. Each project may have different economic impacts, including those of the industries they connect, which can vary significantly.

New Knowledge Insights

New knowledge insights from this research study include the analysis of production structure, production distribution structure, and the construction project network of the Bang Pa–In to Nakhon Ratchasima city–to–city expressway. Furthermore, it suggests incorporating the Bang Pa–In to Nakhon Ratchasima city–to–city expressway into the production and output table of Thailand, as well as improving the existing table to provide a comprehensive overview of the country's economy.

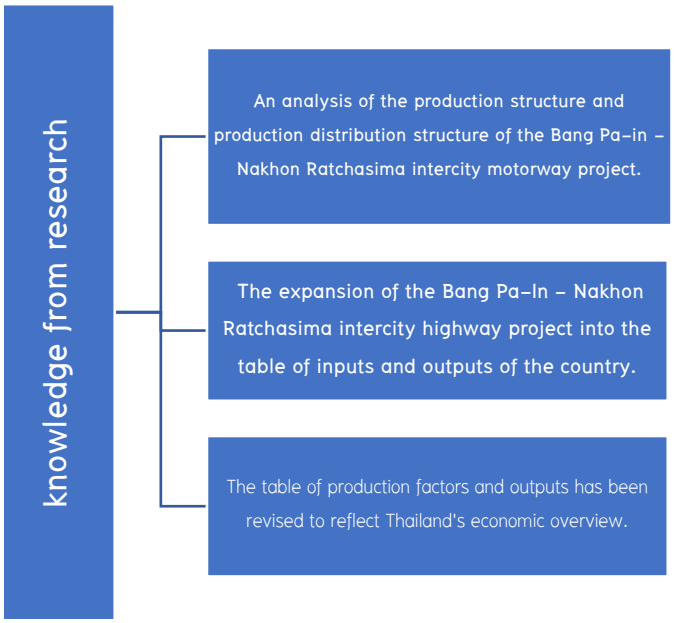

Figure 2 New knowledge from research

From: Designed by researchers

From the aforementioned model, it can be inferred that the Bangkok– Nakhon Ratchasima Expressway project is significant for Thailand. Analyzing the production structure of the project reveals that it heavily relies on intermediate factors at a high level (accounting for 69.83% of the total production cost). The intermediate factors of production include concrete production, quarrying and stone crushing, steel production, cement production, and land transportation of goods. The key issue in this research is that the input–output tables should be updated with the project in order to better reflect the overall effect.

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