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The influence of railway development on the indonesian national economy: an input-output approach

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Abstract. This paper aims to investigate the effect of railway development on the Indonesia national economy with Input-Output analysis. The data used in this study are Input-Output data from 2000 to 2010. Input-Output data analysis generates contribution, value added, intermediate input, final input, linkage and multiple impacts of a railway to other modes of transportation and national economy. The result of Input-Output data analysis concludes that the railway has forward and backward linkage to various sub-sectors, therefore it can become a superior sub-sector to increase national economic growth. The research results find out that if there is a development or investment in the railway subsector of IDR. 1 billion, this, will, therefore, give impact to: (a) the amount of economic output will increase into IDR 1.633767 billion; (b) the income of the society members will become IDR. 362,507 million; (c) will upgrade the employment opportunities into 9.556 people. Accordingly, there is a need to modify the government budget (APBN) that will focus primarily on developing railway transportation, both in goods and passenger vehicles.

1. Introduction

In human's life, transportation plays a very important and strategic role because the mobility of the people from one place to another requires transportation services. Along with the increasing numbers of human's needs for goods and services, it is increasingly important to have a good role in transportation mode. The transportation sector is needed to connect various areas, either by land, sea or air transportation modes. In this context, transportation serves as the economic artery because transport can be made by the movement of people and goods. If mobility is largely facilitated by the transport system more and more often, it indicates the activity and economic development of the region that ultimately can improve the welfare of the community.

In the economic system, transportation is referred to as derived demand, meaning transportation is necessary because of other activities. Transportation needs will increase with increasing economic activity and a decrease in the case of an economic downturn.

The economic benefits of transport infrastructure investment are long-term competitiveness, productivity, innovation, lower production prices, and higher revenues. Investment in transport infrastructure also creates thousands of jobs shortly. A well-performing transport network opens up employment, enabling businesses to grow and lower down the price of home appliances. This will

make the entrepreneurs manage the stock of goods well and efficiently. Transportation makes it easy for suppliers to market their products, making it more cost-effective for the industry to keep their production going.

Railway transport has certain characteristics and advantages, especially in its ability to transport both passengers and goods in bulk, energy-saving, space-saving, high safety, low pollution (more environmentally friendly) and more efficient than road transport.

The railway system is mass transportation that can be used for the transportation of passengers and goods in large quantities so that it's more efficient than road transport.

Table 1. Soil classification based on predominant period.

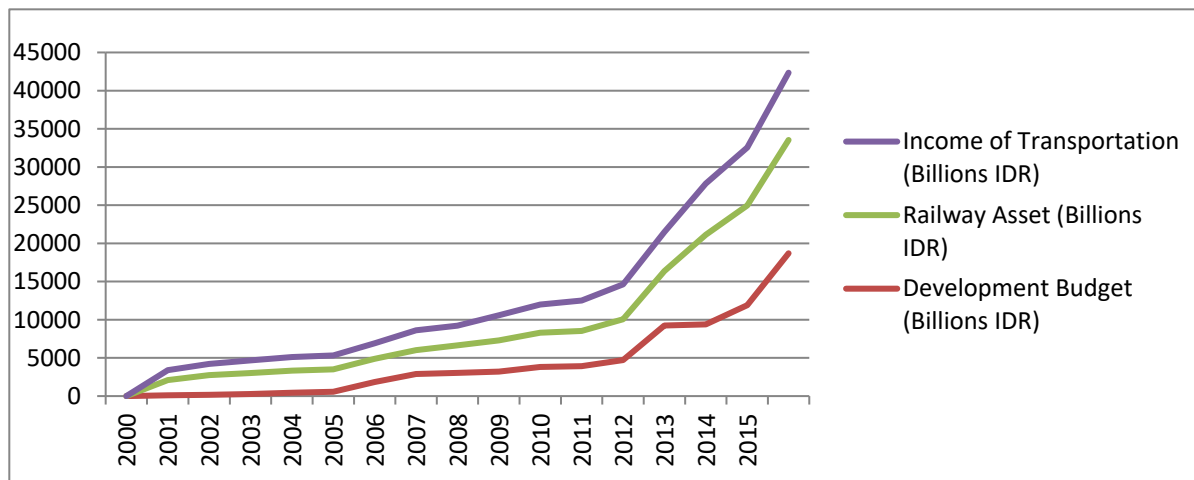| NO.	Transportation Mode	GDP Billion (rupiah)	% GDP	% Transportation
1.	Road Transport	193.257	2,22	55,41
2.	Rail Transport	2.950	0,03	0,84
3.	River, Lake, and ferries	10.222	0,12	2,93
4.	Sea transport	30.173	0,35	8,65
5.	Air transport	57.185	0,66	16,40
6.	Warehouse and support	54.983	0,63	15,77
7.	Transportation	348.770	4,01	100
8.	Gross Domestic Product (GDP)	8.695.000	100,00	

Source: BPS, Indonesia

Figure 1. Graphics of the increment of Development Budget, Railway Asset, and Income.

For urban transport, transportation costs have a significant contribution to economic activity, for example in the Jabodetabek area, rail transportation gives a very real role. The number of Jabodetabek commuter train passengers in November 2017, averaging 1.1 million passengers a day [1].

As shown in table 1, The contribution of the transportation sector in the formation of Gross Domestic Product (GDP) is 4.01%, while railway transportation 0.03%. For the share of transportation mode, road transport dominated by 55.41%, while rail transport was by 0.84%. Despite the fact the value of the contribution of the railway transportation sector is low enough, the development of the railway in Indonesia shows significant growth as in figure.1.

From 2006 to 2016, the average annual growth of passenger transportation is 9%, while the average annual growth of freight transport is 8% [2]. In essence, the focus of government policy in the field of freight and passenger transportation is to optimize the role of each mode of transportation to minimize costs and externalities. The policy is carried out through the integration of several modes of transportation following their respective comparative advantages.

This journal aims to investigate the role of rail transportation and four other transportation sectors in Indonesian economy for the period 2000 – 2010 using the Input-Output approach to provide policymakers with a basic picture of the role of rail transportation sector compared with other sectors. The fundamental purpose of I-O approach is to analyze the contribution of each transportation sector to an output of the whole transportation sector, analyze the linkage of each sector to other sectors, and analyze the multiplier effect of each transportation sector to output, income, and employee.

2. A brief review of I-O analysis on transportation

The I-O analysis could be a good research methodology to explore the influence of railway transportation on the Indonesia economy.

Various research results using I-O analysis have shown good performance in providing policy recommendations, especially to know the linkage between the transportation subsector and its improvement efforts in the national economy.

A study finds empirical evidence of the importance of developing transport infrastructure in accelerating productivity and economic development, particularly for African countries [3]. In line with other research was found that transportation infrastructure has a statistically significant and positive relationship with economic growth in Nigeria [4]. This means that improving the transport infrastructure will boost economic growth.

The research is concluded that the relationship between the transport industry in Taiwan is stronger in absorbing related industrial products than the products used as inputs in other industries [5]. Road, rail and air transport have a strong ability to attract other industries. The effects of the transport sector triggered production high enough and increased from 2.80% in 1991 to 19.41% in 2006. The highest effect was road transport whereas the lowest was water transport, but water transport had the highest effect on job creation, followed by air transport and warehousing sectors.

Transport infrastructure investment in economic development is important as a means to facilitate the mobility of goods and services that facilitate the relationship between remote and growth centers. The smooth flow of goods and services will stimulate economic activity increasing household income [6]. Increased production activities in the transportation sector affect the activities in other sectors, to provide an increase in the economy of the community. The effectiveness of investment in transport infrastructure to improve the economy and provide benefits to the community depends on the utilization of transportation facilities by producers and consumers as well as the leading sectors.

The study found that the rail and water transport sectors resulted in a significant change in sectoral prices in the energy resources sector. This reflects the high dependence of these sectors on the rail and water transport sectors [7].

The study in Thailand resulted there is a growing phenomenon of transportation costs of road transport. This phenomenon leads to shifting modes of transportation from road to other modes [8]. The mode of rail transport is considered as one of the solutions to the problem. The development of rail transport modes and water transport has great potential to boost Thailand's economy through reduced logistics costs.

The study of the University of Illinois counts and evaluates the impact of the damage network as a result of an earthquake as well as the hindrances of the commodity streams against national and regional economy [9]. This uses two different methods of analyses of model I-O multi-regional and model of regional commodity stream. The outcome can be used as a tool to identify the critical part in the transportation network and to analyze the strategy of the after-earthquake reconstruction.

The research has researched the characteristics of different attempts to operate the Hirschman original concept concerning forward and backward with the inception of the Rasmussen Dispersion Index and shift into what is called the interrelated measurement of Hirschman-Rasmussen [10]. The empirical analysis employed with input-output Denmark data of the periods of 1966 to 1992 demonstrates a high stability rate from time to time from the individual interrelatedness, yet the key to the industry "power" becomes weak.

The studies also state that if the input-output model is accurately adopted, the model can be a very beneficial tool to predict the impact of the whole economy from the initial conversion of the economic activities [11]. To enable to use this model effectively, the analyst has to collect detailed information about the project or program being studied. This paper focuses on the information assumption needed to use a comparison of regional input-output accurately, particularly a multiplier yielded in the Regional Input-Output Modelling System (RIMS II).

The studies have researched the top Indonesian economic sector using the approach of I-O with the update data in 2008 of 66 economic sectors [12].

Table 2. Summary of literature review papers.

No	Researchers	Research Settings	Method of Analysis	Research Findings
1.	Seetanah Boopen (2009) [3]	Africa	Analysis I-O	The development of transportation speeds up productivity in Africa.
2.	Rong-Her Chiu dan Yu Chang Lin (2012) [5]	Taiwan	Analysis I-O	The development of the transportation industry gives an impact on the economic sectors.
3.	Li Xuemei, Yan Jun. (2012) [13]	Beijing	Analysis I-O	The Development of railways in China keeps going up despite a rapid decrease in recent years.
4.	Jiang Wang, Michael B.C (2010) [7]	Australia	Analysis I-O multi-sector	The impact of economic investment in the infrastructure of the diverse mode of transportations.
5.	Fukuishi, Hideo.2010 [8]	Thailand	Analysis Input-Output	Thailand possesses a dominant transportation system. But over the last 60 years, there is a development of *BangkokTransit System* (BTS) and *MRT*
6.	Jumpatuah Saragih (2004) [14]	Pematang Siantar, North Sumatra. Indonesia	*Backward Analysis and Forward Linkage*	This demonstrates that the biggest spread power Index Indeks (*backward*) is 1,88517 in the manufacture industry sector and the highest degree of sensitivity (*forward*) of the trading sector is 2,68654.
7.	Tschango John Kim dkk (2002) [9]	America	Analysis I-O Multi-Regional	To identify critical parts in the transportation network and to analyze a strategy of the after earthquake reconstruction.
8.	Glen Weisbrod dkk (2009) [6]	Boston	Analysis I-O	Investment in public transportation gives a significant impact on the economy.
9.	G. Alivelu (2007) [15]	India	Analysis I-O	The elasticity of price, demand, and employment, fuel and capital in the transportation cost functions.
10.	Galina Ivanova dan John Rolfe (2012) [16]	Queensland, Australia	Input-Output Model	The Input-Output technique is used to analyze economic activity.
11.	Lismuba Indriani dan M. Abdul Mukhyi (2013) [12]	Jakarta	Analysis I-O	There have to be 25 economic sectors in Indonesia having a high role in grabbing the income of the society members.
12.	Ina Drejer (2002) [10]	Copenhagen, Denmark	Input-Output Model	The Input-output Analysis in Denmark shows a high degree of stability.
13.	Jeffrey L. Jordan, Stanley R.Thom (2016) [17]	England	Analysis I-O	The I-O effective Method to analyze the railway traffic.
14.	Rebecca Bess Zoe O. Ambargis (2011) [11]	Washington	Analysis I-O Regional	Model I-O will use to estimate the impact of economic development.
15.	Koichi Nidaira [18]	Indonesia	Analysis I-O Regional	The Comparison of Trading stream in Java Island and Outside Java Island

The top sector or key economic sector in Indonesia, there are 12 sectors; namely Trading Sector, Chemical industry, Fertilizers Industry and Pesticides, Others, Property, Machinery Industry, electrical

tools and equipment, FMCG Industry, Land transportation, Electricity, gas, and clean water, Plastic and rubber industry, Poultry, Pulp and Paper Industry, carton and paper made goods.

The study of Zagreb University analyzes the cost structure in the railways sector in India. In his research, data are gathered from the years 1981-1982 and 2002-2003 from diverse publications in *Railway Board*, India Railways Department [15]. Research findings show that the price elasticity of employment is (0,90%), fuel is (1,32%) and capital is (2,22%) against the cost functions. Negative evidence in the cost functions indicates that while the input prices increase, the demand will go down.

The study has conducted a study that evaluates the achievement of industrialization in Indonesia and clarifies the main challenges existing in sustaining the industrialization employing the input-output analysis method [19]. This study finds that the decrease of investment is a pitfall that hinders industrialization and indicates an urgent need for Indonesia to restore the investment environment, specifically to foreign investors.

The study verifies the foundation's mathematics for the economic input-output, main model variants, and the underlying economic theory [20]. These features and models make it very compatible with understanding the relationship between economy and environment stressed out around the world. The most important approach in analyzing this is by involving comparison, decomposition, and scenario analysis.

3. Research methodology

The Input-Output analysis is a good research methodology that can be used to explore the influence of transportation on the national economy. This section briefly introduces the Input-Output analysis used to analyze the inter-sector contributions, inter-sector linkage and multiplier of the transportation sector in the national economy.

The Input-Output tables from 2000 to 2010 provide comprehensive economic data, covering all commodities and economic activities, both commodities produced by the domestic (domestic) and commodity sectors derived from foreign production (imports). Goods and services or commodities produced by the production sector can consist of a variety of different types and physical forms. In the process of analysis of I-O table, the researcher performs a step to classify goods and services into certain groups. This process of grouping goods and services is known as sector classification process. In the practice of preparing I-O table, sector classification is done at an early stage.

The basic balance of the I-O model consisting of 161 sectors can be expressed as:

When read in a linearity:

$$x_{i1} + x_{i2} + x_{i3} + \ldots + x_{i161} + F_i = X_i \tag{1}$$

This equation describes the demand side (demand driven) model as viewed vertically in the I-O table.

When read in a column:

$$x_{1j} + x_{2j} + x_{3j} + \ldots + x_{161j} + V_j = X_j \tag{2}$$

this equation expresses the supply side (supply driven) model as view horizontally in the I-O table.

Where x_{ij} is the inter-industry purchases of producing sector i from supply sector j, X_i is the total gross output in sector i, F_i is the final demand in sector i, V_j is the final value added by sector j.

3.1. Output contribution

The contribution of output is the amount of output from each sector of the economy, so it can be seen which sectors give the largest contribution in forming the overall output. Likewise, the transport sector will be able to know the contribution and share (share) of each mode of transportation that can be expressed as

$$Output\ Share = \frac{X_i}{\sum_{i=1}^{161} X_i}\ x\ 100\% \tag{3}$$

3.2. Interconnected linkages

Linkages measure the level of inter-sector dependence in the economy and the extent to which the sector is affected by other sectors. The Forward Linkage Index (FLI) shows the relationship of the influence caused by one unit of final demand of a sector to the total sales output of all sectors within an economy. The Backward Linkage Index (BLI) shows the power of dispersion. The backward linkage effect and forward linkage effect can be expressed as:

$$FLI = \frac{\sum_{j=1}^{161} b_{ij}}{\sum_{i=1}^{161} \sum_{j=1}^{161} b_{ij}} \ x \ 161 \tag{4}$$

and

$$BLI = \frac{\sum_{i=1}^{161} b_{ij}}{\sum_{i=1}^{161} \sum_{j=1}^{161} b_{ij}} \ x \ 161 \tag{5}$$

A comparison of the strength of the backward and forward linkages for the sectors in a single economy provides one mechanism for identifying the key or leading sectors in that economy. The transportation industry linkage means that the production activities of the individual sector may induce greater use of other sectors as input for transportation production or may be used as an input for other sectors in their production.

3.3. Interconnected Linkages

The Leontief [I-A]$^{-1}$ is the opposite matrix from table I-O or multiplier matrix (M) where:

$$M = [I\text{-}A]^{-1} \tag{6}$$

M = multiplier matrix/
I = Identity matrix 161 x 161
A = technical coefficient matrix of 161 x 161
There are three variants of multiplier analysis that will become the focus in this journal; (1) Output Multiplier; (2) Income Multiplier; and (3) The multiplier of employment, where they can be determined in the Multiplier Output Number (Mo):

$$M_o = [I\text{-}A]^{-1} \ F \tag{7}$$

where [I-A]-1 is multiplier matrix and F is a stimulus of final demand of the related sector.
The Income of Multiplier Number (Im) of Sectoral employee:

$$I_m = \hat{V} \ [I - A]^{-1} \ F \tag{8}$$

where $\hat{V}$ is a matrix of diagonal coefficient sectoral income, F is the stimulus of final demand.
Sectoral Employee Multiple Number (Ml):

$$M_l = \hat{L} \ [I - A]^{-1} \ F \tag{9}$$

where $\hat{L}$ is a matrix of the diagonal coefficient of sectoral employment and f is the stimulus of final demand.
Empirical result

4. Output and value added a contribution

In the analysis of the contribution of I-O to 161 sectors, the transport sector can be broken down into the sub-sectors of road transport, rail transport, river, lakes and ferries transportation, sea transport, air transport and other transportation services. This analysis is more focused on the role of each mode of transportation in the national economy shown in table 2.

In Table 2, it can be seen that in 2000 the road transport occupied the highest rank (38.19%) and in 2010 increased its contribution to 52.12%. Sea transport is ranked second in 2010 by 11.62%. Air transport starting in 2000 showed an increase, this is because of the ease in the air transport business that is cheap (low cost carrier) so that the mode of air transport is increasingly in demand by the public.

Railway transport had the lowest ranks with a contribution of 1.15% in 2010, this shows that the contribution of the train is very low considering the limitations of the railway network in Indonesia is limited in Java and Sumatera.

4.1. Interconnected linkage

Based on table 3, it can be seen that the power of spreading and power of sensitivity of mode of railway transportation in the year of 2010 has a different value where the power of spreading is higher than the degree of sensitivity. This indicates that railway transportation mostly uses sectors as an input for a sub railway sector, yet other sectors have not adopted yet as it can be seen from the share lowest railway transportation in comparison with others.

Table 3. Output contribution and value added of transportation mode in the national economy.

No	Modes	The output Year 2000 (IDR.Billion)	The output Year 2010 (IDR.Billion)	Value Added (IDR.Billion)
1	Road Transport	48.498,100	280.201,029	137.428,669
		38,19 %	52,12 %	58,09 %
2	Rail Transport	2.258,074	6.167,960	2.281,640
		1,78 %	1,15 %	0,96 %
3	River, Lake, Ferries	4.589,625	16.492,905	6.695,525
		3,62 %	3,07 %	2,83 %
4	Sea Transport	26.596,337	62.466,287	18.926,170
		20,95 %	11,62%	8,00 %
5	Air Transport	25.296,986	115.290,733	38.094,958
		19,92 %	21,44 %	16,10 %
6	Others	19.754,424	57.020,331	33.161,150
		15,55 %	10,61 %	14,02 %

Source: BPS, Indonesia

Table 4. Forward and backward relationship in mode transportation.

Sector name	Year 2000		Year 2005		Year 2010	
	BLI	FLI	BLI	FLI	BLI	FLI
Rail Transport	0.987622	0.99752	1.000021	1.000129	1.051852	0.658544
Road Transport	1.010031	1.011563	1.009321	0.999003	0.995036	2.556444
Sea transport	1.00083	1.000239	1.000336	0.998572	0.988972	0.712509
River, Lake, Ferries	0.997424	0.993312	0.998752	0.998473	0.850148	0.686808
Air Transport	1.003333	0.992997	1.004002	0.999981	0.761595	0.792362

Source: I-O table of Indonesia [21]

4.2. Multiplier effect

Multiplier analysis (multiplier) is a measurement of a response or an impact of economic stimulus that covers output multiplier, income multiplier and employment multiplier. Output multiplier of railway services is 1,633767 which means the final demand of the railway sector is up to IDR 1 billion, there will be an output of the whole sector of IDR 1,633767 billion. If we compare with other

transportations, railway transportation will give an output impact of the biggest sectors so that if a railway sector is developed by increasing the carrying capacity, there will be potential to lift the final demand. The result of the multiplier output analysis can be seen in table 4.

The changes in the final demand of a sector will also definitely upgrade the household income of the whole sector. The degree of multiplication of this can be seen in the multiplier number of income. the multiplier in Table 5. In table 5, it is indicated that railway transportation services give a valuable impact of 0.363 which means every increment of railway transportation services subsector earns IDR 1 billion, therefore produces the income of the whole household in the economy of the amount of IDR 363 million. Unless there is an increment, the household income in the railway will only earn IDR 292 million.

Table 5. Multiplier value output of diverse transportation mode.

No	Sectors	Output Multiplier
1	Railway Transportation Services	1.633767
2	Land Transportation Services	1.545518
3	Marine Transportation Services	1.536099
4	River and Crossing Transportation Services	1.320475
5	Air Transportation Services	1.182932

Source: I-O table of Indonesia

Table 6. Income Multiplier of Transportation Sector.

No	Sector	Income Coefficient	Income Impact	Income Multiplier
1	Railway transportation	0.292	0.363	1.240
2	Land Transportation	0.161	0.233	1.446
3	Marine Transportation	0.093	0.159	1.699
4	Marine and Crossing Transportation.	0.199	0.240	1.209
5	Air Transportation	0.135	0.159	1.178

Source: I-O Table of Indonesia

Table 7. Employment Transportation Sector Multiplier.

No.	Sector	The Number of Employment in 2010	Coefficient of Employment (people/ billion)	Employment Impact (people /billion)	Employment Multiplier
1.	Railway Transport	44,745	7.254	9.556	1.317
2.	Road Transport	1,120,647	3.999	6.955	1.739
3.	Sea Transport	144,906	2.320	5.323	2.294
4.	River, Lakes, Ferries	81,342	4.932	6.828	1.384
5.	Air Transport	385,138	3.341	4.740	1.419

Source: Data I-O and SAKERNAS

The multiplier of railway sector income is worth 1.240 which means that every additional IDR 1.00 the income of employment in railway transportation will create a national income of IDR 1.240. When we compare with other transportations, railway mode of transportation will give an impact on the biggest economic sector followed by sectors of river transportation, and crossing, land transportation sector, marine transportation and aviation transportation. In line with that, the railway mode of transportation needs priority in development that gives a big income impact on the economic sectors.

The result of the calculations of employment multiplier for the transportation sectors with matrix data computations of 161 x 161 can be seen in table 6. If there is a final increment in the railway demand of IDR 1 billion, it gives an impact on the supply of employment opportunities in the whole sectors of about 9.556 people. If there is no relationship between each sector, the employment opportunity will

only go up into 7.254 people of whom they are needed by the railway transportation sector. The comparison in the impact of the employment opportunity that appears in the whole sector railway transportation is 1,317. This number is said to be an employment multiplier, which means if there is an increase in employment opportunity in the railway transportation sector of 1 person, it will lift the employment opportunity in the whole sectors of 1,317 people.

Compared to other modes of transportations, it is clear that railway transportation gives a multiplier of employment opportunities in the whole sector to a high degree which is in a contrast with other modes of transportation of 9,556 people for every increment of final demand of IDR. 1 billion. The same thing applies to an increase in the employment sector which possesses a coefficient of employment in the highest degree of 7.254 meaning that in every increase of the final demand in the railway transportation of IDR. 1 billion will elevate employment opportunities in the railway sector of 7.254 orangs.

Following the analysis results above, it can be argued that if there is an additional investment in the railway sector, it will elevate the income and the welfare of the society members.

5. Conclusion

In a National Scale, analysis results conducted can be simulated that if there is an investment/ development railway sector of IDR 1 billion, it gives an impact as follows:

- The number of economic out will go up into IDR 1.633 billion.
- The income of the society will be higher in IDR. 362.507 million.
- The employment opportunity will double up into 9.55 peoples.

Therefore, it is significant for the government to lift the government budget (APBN) that prioritizes more in the development of railway mode of transportation, both for goods and passengers.

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