Civil and Environmental Research
ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online)
Vol.3, No.11, 2013

Modal Competition for Freight in Land Transportation on Jakarta-Surabaya corridor

Lita Sari Barus[a], Sigit Pranowo Hadiwardoyo[a] Hipolito Martell-Flores[b], Jean-Louis Batoz[b],
[a]Department of Civil Engineering, Faculty of Engineering, University of Indonesia, Depok 16424
lita_barus@yahoo.com, sigit@eng.ui.ac.id (Corresponding author)
[b]Department of Urban System Engineering, University of Technology of Compiegne, Urban Systems Engineering GSU, Centre PG2, BP 60319, hipolito.martell-flores@utc.fr, jean-louis.batoz@utc.fr

Abstract
As a part of a set of research studies about the railways transport in Indonesia, we propose this results advancement. Nowadays, the freight railways system in Indonesia suffers a complex and an apparently not easy to solve situation. The freight service is in constant degradation and it lost demand progressively, more the new highways development plans threat to increase the attractively of road transport in detriment of railways. The identifications of the structural problems will let us to propose aimed and precisely solutions to broke the current vicious circle of the freight railways system.
Our analysis is supported by questionnaires applied to 93 forwarders/shippers in 186 opinions that usually contract freight transport services on the link. Each forwarder answered the same questions about his/her preferences for rail and for road freight services. We analyzed this data by the Logit model to identify the "factors of service" or variables which influence the decision of forwarders/shippers in the most important way.
The results show clearly the relative importance of some railways "factors and service" in function with the others for the same mode, as well as their relative influence for the modal decision compared with the road freight transports.
This paper aims to identify the structural problems of the freight railways service of "KERETA API" in the Java Island, especially between the cities of Jakarta and Surabaya which are the most important city in Indonesia.
Key words: Indonesia railway development, modal competition, freight transportation, modal choice

1. INTRODUCTION

Indonesia is an archipelago country with many islands, but most of its people lived in Java Island (around 70%) and concentrated in some cities. Jakarta is the biggest city and most peopled, Surabaya city is the second one. The connection between those two cities is very important, especially for the freight transportation. This link supports the huge flux of general consumption supplies between the main cities of the intermediate regions. The freight transport on the link is principally realized by truck and train and we can consider this link as representative of the integral rail and road freight services competition in the country. For the shippers and forwarders, the truck is in general more attractive than train.

On explanation is that the highways infrastructure has been developed more intensively in the last 20 years while rail infrastructures rest the same. The augmentation of connectivity and quality of the road network increase naturally it's attractively. But the lost of freight rail services attractively is principally linked with diminution of its own quality. We assume this hypothesis "a priori", because the highways connection between the cities does not exist still. Today, there exist some segments of highways on the link but for the short distances and often unconnected between them. This lack of connection proves that there are the internal structural problems of the freight railways service by self.

Today, there are many railways lines which run with negative incomes. In this situation, it is hard to maintain and also to invest for renewing its infrastructure and roll materials. In general, the investment in railway infrastructure needs heavy investments with a long term period of breakeven point. Then, in this bad climate of investment, it is very difficult to increase the rail level to service. Many of railways lines run with bad conditions and competition factors are negligees. Almost 30% of railways lines were abandoned in Java. Nowadays, the railways system is in a financial critically situation which provoke insufficiencies of infrastructures maintenance. In the next future, all cities in Java will connect by the highways system, called "Transjava Toll Road". The improvement of highways network connectivity and capacity suppose the increase of the road attractively for transport of freight. This perspective implies two problems, "the total decline of rail in the freight transport" and

"the fast saturation of the new highways by a huge occupation by the truck traffic" provoked by an eventual massif transfer of freight from the rail to the road services as soon as possible in order to maintain a competition between modes as well as to find an equilibrated situation for develop both modes in sustainable way.

So it's necessary to improve the railway's competitiveness to get its demand higher. In this paper, we focused on the evaluation of characteristics of transports which influence the modal choice. These characteristics are represented by variables linked with the satisfactions and preferences of freight forwarders/shippers as users of transports on the Jakarta-Surabaya corridor. Our data were obtained from a survey in 2011 through questionnaires applied to user of rail and truck on the corridor. We applied a methodology and a Logit model for modeling the modal competition. This theoretical model of the problem lets to identify some values that show us some significant factors/variables from the preferences of freight forwarders/shippers in Indonesia. We found some values to discriminate variables which are not really important into the modal choice and another set of variables which represent satisfactory characteristics of current transport service.

We develop a statistical analyze base on the data from applied questionnaires to freight forwarders/shippers of rail and truck service on Jakarta-Surabaya corridor (Figure 1). This preferences analysis considers 11 variables linked with the transports characteristics which influent the modal choice of freight distribution. The results show the importance level of each characteristic on the modal choice for railway in this link.

Source: Indonesia Matters, 2006-12

Figure 1 Railway Lines in Java Island with Jakarta-Surabaya Corridor

2. THE CONTEXT OF JAVA SUPPLIES CHAINS AND FREIGHT RAIL SERVICE

Normally, the train has the possibility to transport large volumes of freight and provide a better adjustment capacity to absorb the peaks of demand in the certain period [1]. So, the railway has real opportunities to maintain an important level of demand and even to develop it, but it still not happen currently in Indonesia, especially for the line Jakarta-Surabaya as a long distance line. In 2010, total population in Java Island was more than 136 million people (see Table 1)[2]. This population increase and will need continuity guaranty of freight distribution which will increase too in the near future. The link is through some provinces from DKI Jakarta to East Java and all of these populations are increased. Other problem is the significant number of railway accident. From 2002 to 2005, only in Central Java, there were average railway accidents 13 times per year[3].

Nevertheless, today's train demand does not correspond with these railway's advantages over the other modes. It has a bit faster (11 hours) than truck (12 hour). We explore the modal competition through the preferences of the corridor transports' users, freight forwarders/shippers, in order to define the most important characteristics to enhance its competitiveness over truck as well as their priorities.

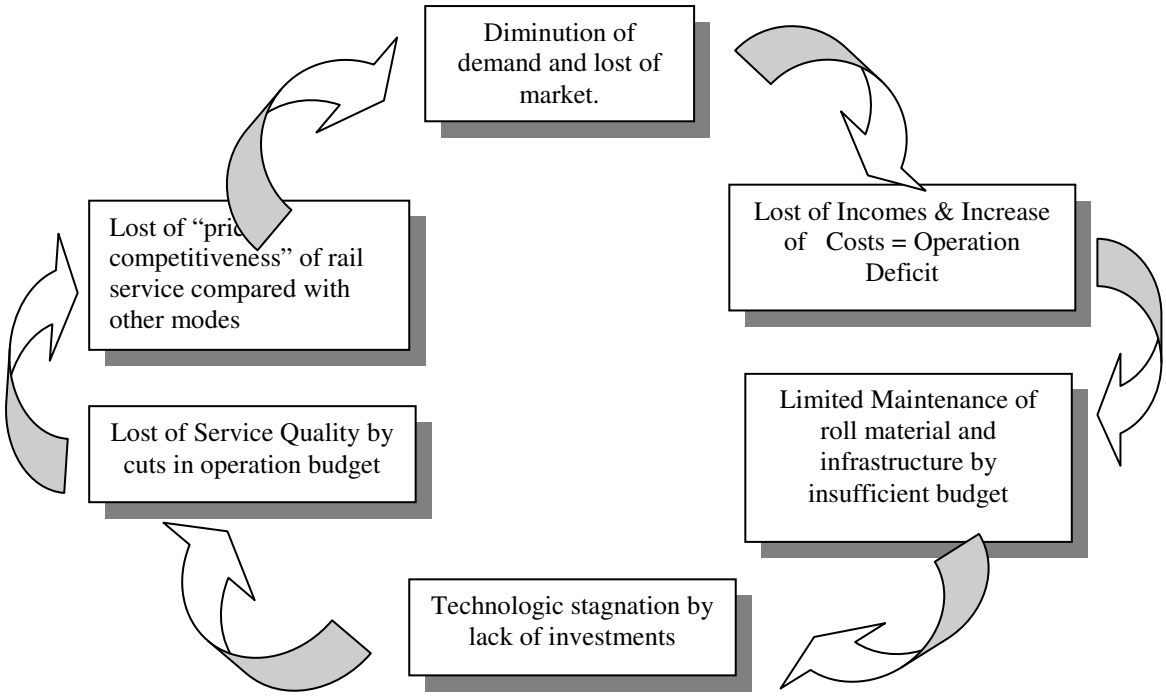
The objective of this research is the identification of significant "satisfaction variables" of freight forwarders/shippers' preferences linked with different characteristics of transport modes to compare between modes and to propose solutions in order to improve the participation of the rail transport into the modal competition. We define the principal advantages and disadvantages of rail service in comparison with road

transportation to understand better the modal competition between cities. We test the significant variables to be improved in the future in order to develop railway in Indonesia.

Table 1 Java Island Population

Provence	Population						
	1971	1980	1990	1995	2000	2009	2010
DKI Jakarta	4 579 303	6 503 449	8 259 266	9 112 652	8 389 443	9 478 385	9 607 787
West Java	21 623 529	27 453 525	35 384 352	39 206 787	35 729 537	42 258 343	43 053 732
Central Jawa	21 877 136	25 372 889	28 520 643	29 653 266	31 228 940	32 265 393	32 382 657
DI Yogyakarta	2 489 360	2 750 813	2 913 054	2 916 779	3 122 268	3 422 409	3 457 491
East Java	25 516 999	29 188 852	32 503 991	33 844 002	34 783 640	37 198 318	37 476 757
Banten	-	-	-	-	8 098 780	10 346 692	10 632 166
Total	76 086 327	91 269 528	107 581 306	114 733 486	121 352 608	134 969 540	136 610 590

Source: BPS, 2011



L.BARUS and H.MARTELL, 2013, AVENUES-GSU, University of Technology of Compiègne, France

Figure 2 The Vicious Circle of Railway Jakarta-Surabaya

3. DEFINING THE STRENGTHS AND WEAKNESS OF RAIL INTO THE MODAL COMPETITION

To define the strengths and weaknesses of rail into the modal competition we based our analysis on data from questionnaires applied to freight forwarders/shippers in corridor in 2011. This survey consisted in 93 questionnaires applied to forwarders/shippers that used train and truck in the corridor with total 186 opinions. The data was used to compare the different characteristics of transport modes through the application of a binomial logit model. We obtained a "Utility function by mode" U mode x integrated by variables Vi. The variables Vi represent the different factors or characteristics of transport modes evaluated by the logit model based on the data of user's preferences.

The βi parameters represent the utility of "improve the specific factor" for the correspondent transport mode. For example, if we obtain βi parameters with values near from 0, the improvement of these characteristics will have a few or no significant impact to increase the competitiveness of the correspondent transport mode. Whereas, the higher βi value means important and the higher variable Vi is significant to the choice for the correspondent mode. The positive values for βi, mean that the improvement of the correspondent characteristic or variable Vi could have a useful impact for increase the demand for the correspondent transport mode. Thus, we can call the positive factors βi, Vi as "factors to improve" or current "weakness" of the correspondent transport mode. The negative βi values, means that the improvement of the correspondent characteristic or variable Vi, is not really necessary because its actual condition satisfied the expectations of users. So, their eventual improvement will not be useful or "really significant" for increase the demand of the correspondent transport mode. We can call the negatives factors βi, Vi as "satisfied factors" or the actual "strengths" of train or truck. We could compare directly between the 2 modes of transport, we chose the "truck" characteristics as reference because it is the other mode in comparison. Then the truck factors and its utility function are intentionally zero (βi, Vi = 0, $U_{truck} = 0$).

4. METHODOLOGY

The data were collected through a direct "field survey" based on distributed questionnaires. They were distributed in Jakarta to forwarders/shippers that sent their goods to/from Jakarta and Surabaya for any kinds of goods. There are 93 questioners that each questioner was answered by forwarder/shippers with their opinion about service distribution by truck and train. Data collection was intended to identify forwarders/shippers preferences. We used stated preferences and we got 186 opinions for the binomial logit model which applies a behavior-oriented approach. [4] Discrete choice obtained from the questionnaire translated into the size of the ordinal and nominal data with "Likert scale" (see Table 2)[5]. Each opinion has 4 rank of value. The highest value becomes good and the less is in bad condition. We exclude the medium value due to the unique characteristics of Indonesian respondents that always tend to choose the medium level of opinion. Then, we consider the different preferences by shippers/forwarders of transportation mode alternatives (via a utility function) [6]:

Table 2 Likert Scale

No	Rank of Answer	The Condition
1.	1	Very Bad
2.	2	Bad
3.	3	Good
4.	4	Very Good

$U = f(V_1, V_2, V_3, ..., V_n)$ ..... (1)

where:
U = value of travelers' satisfaction with mode of transportation
f = functional relationship
$V_1 \ldots V_n$ = variables affecting the satisfaction score using a particular mode of transportation.

This approach is represented by error element that is random or stochastic, so the model becomes as follows [5]:

$U_m = \beta_0 + \beta_1 V_{1m} + \beta_2 V_{2m} + \beta_n V_{nm} + e_n$.....(2)

where:
U_m = utility function satisfaction using the mode "m", such as train or truck
V_{nm} = variable "n" of mode "m"
$\beta_1, \beta_2, \beta_n$ = parameter function of satisfaction for each of these variables
β_0 = constant
e_n = error factor, for example the random variables that follow a particular distribution form

Utility function was used to measure the degree of satisfaction obtained by a person choosing one mode of transport. This utility function depends on individual factors of each transport service. Utility function is usually expressed as a linear number of independent variables affected by β factors. In our case, the utility functions and the variables to analysis become as follow:

U_{Rail} ≡ Utility function for train;
U_{Truck} ≡ Utility function for truck;
V_1 ≡ Punctuality
V_2 ≡ Frequency
V_3 ≡ Price
V_4 ≡ Duration
V_5 ≡ Safety
V_6 ≡ Mode's reliability
V_7 ≡ Facility (for loading and unloading)
V_8 ≡ Operator's reliability
V_9 ≡ Security
V_{10} ≡ Accessibility
V_{11} ≡ Freight condition at destination

Logit models are specified on the basis of utility function (U_m) and are applied according to the probability of an individual selecting a mode out of several numbers of total available modes. For two modes, truck and train, we use binomial logit model[6]:

$$P_{(truck)} = \frac{e^{U_{truck}}}{e^{U_{truck}} + e^{U_{train}}} \quad \text{.....(3)}$$

$$P_{(train)} = \frac{e^{U_{train}}}{e^{U_{train}} + e^{U_{truck}}} \quad \text{.....(4)}$$

Where:
$P_{(train)}$ ≡ Probability of choosing train
$P_{(truck)}$ ≡ Probability of choosing truck
e ≡ exponential

5. ANALYSIS OF SIGNIFICANT VARIABLES. DETECTING FACTORS TO IMPROVE FREIGHT TRANSPORT SERVICES

Before the data were analyzed according to the model, the first test is the data quality. The test of data quality is performed by checking the entry questionnaire for forwarders/shippers' preferences up to twice verifications. After verification we saved data as data adjustment. We found that data distribution is extreme value distribution. Table 3 shows data descriptive variables (V_1, V_2,…,V_{11}) and function (U). We ran and found utility function for train and truck as follow (Table 3):

$$U_{train} = -2.418 + 0.530\,V_1 - 0.868\,V_2 + 0.650\,V_3 - 0.129\,V_4 + 0.533\,V_5 + 1.335\,V_6 - 0.335\,V_7 + 0,686\,V_8 + 0.351\,V_9 - 2.425\,V_{10} - 0.178\,V_{11}$$

……(5)

U_{truck} as reference = 0

Table 3 Descriptive Data Statistic

Function	N	Minimum	Maximum	Mean	Std. Deviation
U	186	1.00	2.00	1.5000	.50135
Variables	N	Minimum Satisfaction Value	Maximum Satisfaction Value	Mean	Std. Deviation
V1	186	1.00	4.00	2.7312	.53301
V2	186	1.00	4.00	2.6559	.65751
V3	186	1.00	4.00	2.7097	.54188
V4	186	1.00	4.00	2.8011	.51800
V5	186	1.00	4.00	2.7312	.62627
V6	186	1.00	4.00	2.8441	.53260
V7	186	1.00	4.00	2.7688	.55536
V8	186	1.00	4.00	2.8763	.55095
V9	186	1.00	4.00	2.7366	.58859
V10	186	1.00	4.00	2.6989	.88574
V11	186	1.00	4.00	3.7366	.65797
Valid N (list wise)	186				

Table 4 Influence Weight of Choice Variables on Rail Utility Function

Parameter Estimates

U[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
1.00	Intercept	-.418	1.638	.065	1	.798			
	V1	.530	.555	.912	1	.340	1.699	.572	5.042
	V2	-.868	.496	3.061	1	.080	.420	.159	1.110
	V3	.650	.453	2.054	1	.152	1.915	.788	4.658
	V4	-.129	.513	.063	1	.801	.879	.322	2.401
	V5	.533	.437	1.485	1	.223	1.703	.723	4.012
	V6	1.335	.566	5.555	1	.018	3.801	1.252	11.536
	V7	-.335	.404	.686	1	.407	.716	.324	1.580
	V8	.686	.571	1.444	1	.229	1.986	.649	6.082
	V9	.351	.463	.574	1	.449	1.421	.573	3.524
	V10	-2.425	.440	30.314	1	.000	.088	.037	.210
	V11	-.178	.359	.247	1	.619	.837	.414	1.692

Note:
B column shows the coefficient of rail influence variables
Train's code ≡ 1
Truck's code ≡ 2; as the reference

The comparative reference value is 0, it represents the “truck” mode preferences. When factors are positive for “rail”, it means that users have current preferences for “truck”. Positive coefficients for “train” mean that the correspondent variables are the most important factors to improve their own competitiveness.

Before using the model for future condition, we have to test with some indicators, such as Index value of the likelihood ratio (rho-squared = ρ^2). ρ^2 have a range of values between 0 and 1, the higher the value of the

likelihood ratio (L) above the other, more important / significant difference in the value of L (β) and L (c) or L (0). It shows the distribution of the data being analyzed.

Rho squared (ρ^2) value is similar to R^2 in linear regression. Index likelihood ratio = ρ^2 interval 0.2 to 0.4 shows the relevance of the data is excellent and can be compared to the value of R^2 of the linear regression interval 0.5 to 0.8. [7] [8] In this case ρ^2 are in interval 0.377 to 0.543 (Table 5). It means the relevance of the data is excellent.

Chi-square test is used to check the accuracy of models and is used to test the null hypothesis (H_0) that all variable coefficients V_i (explanatory / independent variable) regression model is zero, but does not imply not constant. The alternative hypothesis (H_a) is the set of variable V_i coefficient is not zero.
The result of influence weight of choice variables on rail utility function is estimated in Table 4.

Table 5 ρ^2 value

Cox and Snell	.407
Nagelkerke	.543
McFadden	.377

If H_0 is accepted means that the resulting model cannot be used to predict the value of the dependent function, otherwise if H_0 is rejected, then the model result can be used to predict the value of the dependent function. In this case, χ^2 count > χ^2 table and H_0 is rejected (Table 6). χ^2 count = 123.419 and χ^2 table = 97.329. So the model result can be used to predict the value of the dependent function.

Table 6 Model Fitting Test

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	220.748			
Final	123.419	97.329	11	.000

Significance test is to determine the coefficients obtained from the results of the estimation can be accepted as the regression parameter estimator of the population. In general, we test significance from the coefficient for each independent variable. H_0 is accepted means that the resulting model cannot be used to predict the value of the dependent function, otherwise if H_0 is rejected, and then the resulting model can be used to predict the value of the dependent function. The value of t student [9] was known as significant value (Sig.) with the amount of the value less than 0.05 (<0.05) for the quality level of 95%. [10] The model has t student value which has some values less than 0.05 (Table 5). H_0 is rejected. Its means the resulting model can be used to predict the value of the dependent function.

6. INTERPRETATION OF RESULTS. DETECTING FACTORS TO IMPROVE COMPETITIVENESS OF RAIL BY COMPARISON WITH TRUCK

The results show the factors of the current low competitiveness of the freight rail transport. In order of disadvantage they are: Mode's reliability, Operator's reliability, Price, Punctuality, Safety, Facility (for loading and unloading) and Security. Only the Accessibility and Frequency are advantageous factors of rail transport in comparison with road.
In fact, the high "Price", as well as the lacks of "mode's reliability" and "punctuality", is today the main problems of the freight transport by train.

The prices of rail services have to be reviewed in order to make it competitive with road freight transport. Users in general, considered that train offers higher prices than road and that the rail services do not offer enough quality for their money. An important part of the current rail users may change of transport mode if the price of rail transport increases because they are in the limit of the modal change decision. The price variable influence freight transport performance. [11]

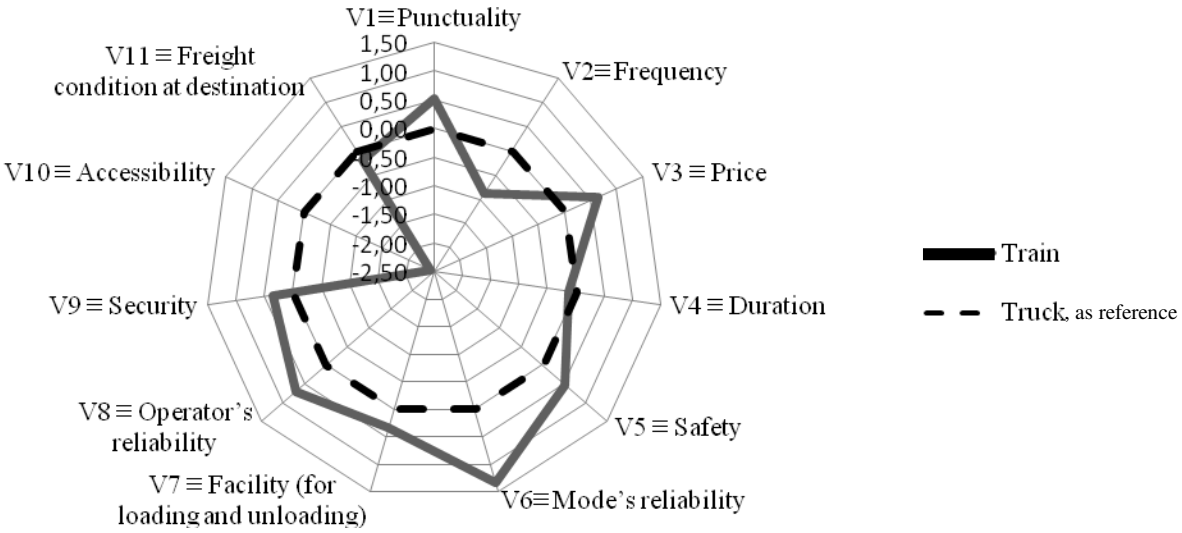


Figure 3. Influence variables coefficients for freight services

This fact shows the dramatically situation of railways and the urgency to break the "vicious circle" of its current operation[12]. The increase of "the prices" of transport to improve the operator's incomes is not a good solution in the short term and may to have an opposite effect by discouraging a part of current train demand. In all case, the improvement of quality service about *reliability, punctuality and goods safety* has to be done before an eventual increase of prices to diminish the risk of loss demand by a travel cost increase.

The suggested improvements do not represent high investments in comparison with the damages that a continuity of loss of demand may provoke. The next step, is the cost evaluation of these improvements one by one and the definition of the ratios "benefit/investments", to realize at least the less expensive improvements in the short term.

The main advantages of train "Accessibility" and "Frequency" are the factors to exploit as maximum into the modal competition. Effectively, all users of road transport are confronted with the problems linked with the traffic jams in the cities of Jakarta and Surabaya. Then, minor investments in infrastructure to facilitate the freight loading and unloading and the connectivity of rail with ports, industrial zones and logistics platforms, may bring huge benefits in efficacy and quality of freight transport and rail transport attractively into the modal competition.

By the moment, the factor of travel *Duration* is in an indifferent factor in the modal choice. But the new high way link between Jakarta and Surabaya will change this competition condition. Thus, the rail system need to do improvements in "rail connections" and invest in "loading/unloading" equipments in order to diminish too the global transport delays.

Eventually, even a modal change could be done from the road to the rail freight transport if this quality improvement "*reliability, punctuality and goods safety" (RPS)* is done in keeping the same prices for shippers and forwarders. New commercial mechanisms have to be explored, as "*contract schemes"* and *"special advantageous rates"* to retain the main customers in exchange of their engagement to send important freight volumes by train.

7. CONCLUSION

The urban activities in Java Island have a constantly increase as well as their interactions. These interactions have the necessity of massif transport between the cities and might increase the rail transport demand, especially for freight transportation in the case of Jakarta-Surabaya corridor. The increase of rail demand is not only a possibility to develop the rail link but a necessity to maintain the operation of the rail service.

In current situation, railways service is critical and cannot fulfill its demand requirement. As a consequence it loses of its demand, the rail incomes decrease, and it loss competitiveness faces to road transport by lack of investments. It is necessary to break the “vicious circle” of the current railway service dynamic. Based on our Logit analysis results, we defined the principal disadvantages of rail into the modal competition. The principal disadvantages may be eliminate or diminish by "internals" solutions. The quality improvement “RPS” is the main internal priority for the rail system. It is necessary to profit of these opportunities to break the “decaying tendency” of rail service, and to generate enough incomes to continue the rail development link. About prices, we suggest to maintain the general rates for freight transport at least until done the improvement of quality service “RPS” to diminish the risk of lost demand again, and the exploration of new contract forms to retain the main customers. Our future research will be oriented in this sense.

ACKNOWLEDGEMENTS

The authors would like to thank to Ministry of Education and Cultural of Republic of Indonesia and France Embassy in International Joint Research Program 2013, and to the undergraduate students from Civil Engineering Department, Faculty of Engineering, University of Indonesia, for serving as surveyors for the primary data for this research.

REFERENCES:

1. Concepcion, R, E., Carlos, M, (2006), *Competition of High Train With Air Transport : The Case of Madrid-Barcelona*, Journal of Air Transport Management
2. Biro Pusat Statistik, *Indonesia Dalam Angka 2011*, Jakarta, 2011
3. Tim Peneliti Balitbang Provinsi Jawa Tengah, (2007), *Penelitian Tentang Keselamatan Dan Keamanan Di Lintasan Kereta Api Se-Jawa Tengah (Ringkasan)*, Badan Penelitian dan Pengembangan Provinsi Jawa Tengah, Semarang, pp 1-2
4. Ahern, A. A., Tapley, N., (2007), *The use of stated preference techniques to* m*odel modal choices on interurban trips in Ireland*, Transportation Research Part A: Policy and Practice
5. Likert, Rensis (1932), *A Technique for the Measurement of Attitudes*, Archives of Psychology 140: 1–55
6. Ben-Akiva, M., Lerman, S.R., (1985), *Discrete Choice Analysis: Theory and Application to Travel Demand*, The Massachusetts Institute of Technology, the MIT Press, Massachusetts, p.384
7. Hensler, D.A , et all, (1998), *Applied Discrete - Choice Modelling*, A Halsted Press Book, ISBN 0470270780, 9780470270783, page 5
8. Nash, Crist, (2007), *Railway*, Edward Elgar Publishing, Incorporated, ISBN1840645539, 9781840645538, 524p
9. Santoso, S., *Statistik D/ Spss 11.5+dsk*,(2000) Elex Media Komputindo, ISBN 979204888X, 9789792048889, page 177
10. Hogg, Robert V, Allen T. Craig., (1978), *Introduction to Mathemetical Statistics*, Macmillan Publishing Co., Inc, New York, 438p
11. Mahmudah, N., (2011), *Pengembangan Metodologi Perencanaan Transportasi Barang Regional*, Jurnal Transportasi Vol. 11 No. 3, pp 173-182
12. Hadiwardoyo S. P., Barus L. S., Batoz J.L, Martell-Flores H., (2013), *The opportunity for Railway Development between two connected Urban Areas at “Jakarta-Bandung” corridor*, International Journal Engineering Science, ISSN 0975- 6469, Vol 5, No 1, Page 29-46.