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Original Article

Ponorogo Prediction of Capital Shift of Private Vehicles and Buss to Rail Transport as Implication of Reactivation Plan for Madiun – Ponorogo Indonesia

Nanda Ahda Imron [1], Ary putra Iswanto[2], Arinda Leliana[3], Septiana Widi Astuti[4]

Indonesian Railways polytechnic
Jl. Tirta Raya, Pojok Nambangan Lor, Kec. Manguharjo, Madiun, Jawa Timur Indonesia 63161

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Abstract *- Railway services are increasingly being needed. This triggered the government to prepare a National Railway Master Plan (RIPNAS) in which various plans for the construction of new railways were included, including the reactivation of existing and inactive railway lines, one of which was the Madiun - Slahung train route, which according to the document would be undertaken in 2025. An analysis is carried out to support the railway development to predict the modal shift to the railway mode when the route becomes truly active. The binary logit method can be analyzed the probability of modal shift from motorbike to train, car to train, and bus to train. If the cost of transportation using a train is Rp.10,000 lower than that of a motorbike, the probability of using a motorbike will be 84%, 16% of motorbike users will switch to using the train. If the cost of transportation by train is Rp.10,000 lower than that of a car, then the probability of using a car will be 57%, 43% of car users will switch to using the train. If the cost of transportation using rail is the same as by bus, then the probability of using rail is 93%.*

Keywords *- Reactivation, Modal shift, Binary logit.*

I. INTRODUCTION

The existing railway transportation system in Indonesia is a legacy of the dutch east indies colonial era. In its development to date, this railway transportation system has experienced ups and downs. Starting with the allies' defeat during the first world war, when japan invaded Indonesia, hundreds of kilometers of railroad tracks were transferred to Myanmar to support Japanese soldiers and logistics distribution. After the independence of Indonesia, it is seen that there is no part in development on the side of railroad transportation, so that it is gradually being abandoned, losing to its main competitor, namely the road transportation mode [1]. Many railways that have been turned into settlements or rice fields, or even have disappeared, are evidence that Indonesia's railroad transportation is in decline. Among them occurred at the madiun-slahung (ponorogo) service line, where the railway tracks were difficult to identify because they had changed their function to become a place of commerce or were even affected by road widening [2].

Concentration in developing railway transportation in Indonesia began to be felt in 2005, marked by the approval to establish the directorate general of railways (djka) by the president of Indonesia to improve public services and accelerate the development of railway infrastructure [3]. Over time, in the context of efforts to implement improvements to railway services and infrastructure, the djka has compiled a roadmap outlined in the national railway master plan document, known as ripnas. In the ripnas, the madiun-slahung railway line is one of the routes that will be reactivated by the government, which is planned to begin the process in 2026 [4]. The route's reactivation is expected to increase community mobility between madiun city - madiun regency - ponorogo regency to encourage increased economic growth in the region. In its history, this railway line was the favorite of the community until the 1970s. However, in 1982, the route was declared dead because it could not compete with the highway mode [2].

By paying attention to historical aspects and to support the intended reactivation plan, it is deemed necessary to raise the topic of prediction of the capital shift of personal vehicles and bus to rail transport as the implication of the madiun - ponorogo train reactivation plan as an effort to estimate the percentage of people who will switch using trains compared to various types of existing modes of transportation such as private vehicles or buses connecting slahung (ponorogo) with madiun.

To determine how the community will respond if the Madiun-Slahung railway service is reactivated, how many people will use the service. That the train service is not yet available, it is assumed that the service will be similar to similar train services such as Jenggala or Batara Kresna trains. In the private vehicle user group, there is an opportunity *for shift capital* to a relatively high where a significant difference in transportation costs between private vehicles and train services will only trigger a mode shift. Meanwhile, in the bus users group, it is suspected that there is an opportunity *for shift capital* to a relatively high where the relatively low difference in transportation costs between buses and train services has triggered a mode shift.

II. RESEARCH METHOD

An easy way to comply with the conference paper formatting requirements is to use it as a template and type your text into it.

A. Binary Logit

The general formulation of the binary logit model is as follows. If it is known [22]:

personal vehicle cost = C_1

public vehicle cost = $C_2 + \delta$ (δ = *capital penalty*)

Then:

$$P1 \quad = \frac{1}{1 + \exp\{-\beta\,(C2 + \delta - C1)}$$

so that

$$P1 \quad = \frac{1}{1 + exp\{-\beta C2 - \beta\delta + \beta C1\}}$$

$$P1 \quad = \frac{1}{1 + exp\{-\beta\delta - \beta C2 + \beta C1\}}$$

$$P1 \quad = \frac{1}{1 + exp\{-\beta\delta - [\beta(C2 - C1]\}}$$

Where:

$\beta\delta$ = regression constant (a)

δ = regression coefficient (b)

In the linear regression equation

y = a + bx

With:

y = Log_e (p_1/ p_2) or LN (p_1/ p_2)

x = C_2-C_1

p_1 =% use of private vehicles

p_2 =% use of public transportation

LN = natural logarithm

B. Population and sample

Taking into account the availability of resources, the scope of data collection is the residents around Slahung Station with a radius of 1.2 km [6] with a travel pattern from the Slahung Station zone to the Madiun Station zone or a trip from the Slahung Station zone to the Ponorogo Station zone. In data collection, it cannot be separated from the number of samples that must be taken. Sample needs, according to Slovin, are as follows.

$$n = \frac{\mathrm{N}}{\mathrm{N}d^2 + 1}$$

Where:

n = number of samples observed

N = number of known population = 49,288 people [24]

d =tolerance *error* = 5%

n = 397 people

C. Data

Needs Appropriate and objective requirements are required. Data needs include user characteristics and transportation costs incurred by the user and formulated into a survey form. However, it is only limited to the daily commuters between Slahung-Ponorogo or Slahung-Madiun.

- User characteristics components include
- Age, gender, occupation, income, length of time worked.
- Origin of daily travel destination
- Daily use of vehicles

Approval if the Slahung-Madiun Railway is reactivated

Percentage of KA use if it has been reactivated

2) The component of user transportation costs includes the accumulated travel time and the accumulated travel costs borne by the traveler.

D. Data Analysis Method

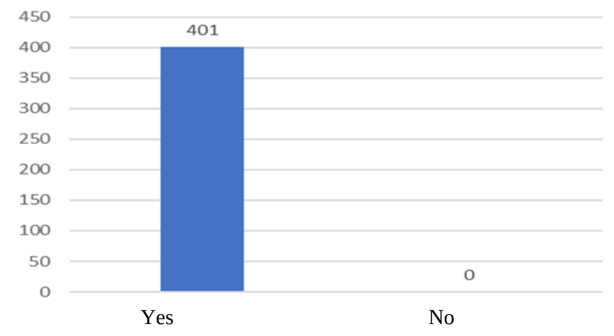
After data requirements are met, the next step is to recapitulate data and analyze data in the workroom. The data analysis stages are as follows.

a. Analysis for *Generalized cost* each sample of motorbike users
b. Analysis for *Generalized cost* each sample of private car users
c. Analysis for *Generalized cost* each sample of bus users
d. Analysis for *Generalized cost* each sample uses motorbikes, private cars, or buses when traveling by train. Since the train service in question does not yet exist, assumptions need to be built first.
e. Building a *capital shift* model between motorbike and train, private car by train and bus by train
f. Test the classic assumptions of the model *modal shift* between motor and train, private car to train and bus to train
g. Analysis of the capital shift's opportunity to the model *of shift capital* between motorbikes and trains, private cars by train, and buses by train at various levels of transportation costs.

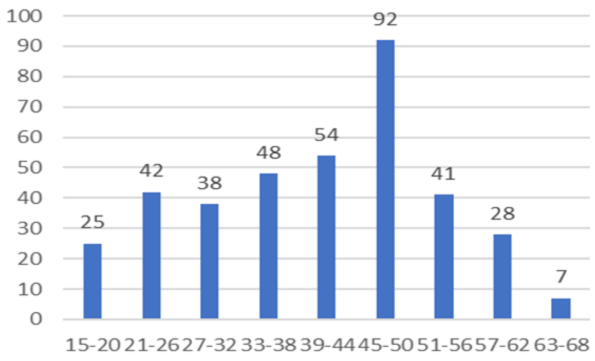
III. RESULT AND DISCUSSION

A. Characteristics of Travel Actors

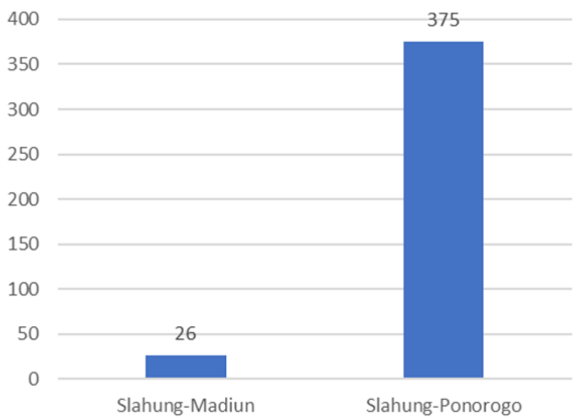
Of the 397 survey samples required, a total of 401 samples were obtained. The sample of the trip to Madiun was only 26, not meeting the minimum sample requirements for analysis. The characteristics of the 401 travelers of Slahung-Ponorogo and Slahung-Madiun are as follows.



Reactivation Agreement

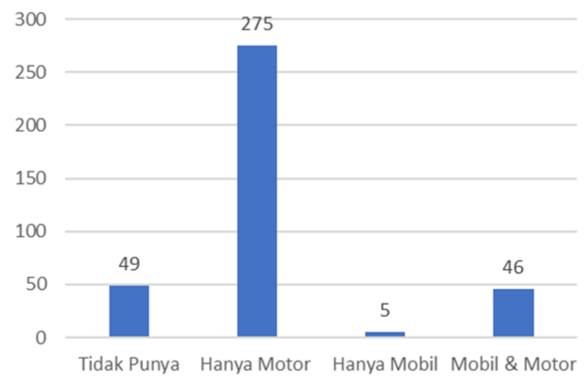


The Age of the Traveler



Number of trips (person)

Traveling Profession



The Traveler's Vehicle

a) Assumptions

a. PP trip - commuter
b. Travel time Sta. Slahung - Sta. Png = 30 minutes
c. Travel time with Kend to Sta. Png = 5 min
d. Time to walk to the station = 15 minE.
Pnp has known the train departure schedule, waiting time at Sta. = 5 min
f. Hourly motorbike parking rates at Sta. Png = IDR 1,000
g. Hourly car parking rates at Sta. Png = IDR 2,000
h. Train ticket price = IDR 6,000
i. Motor fuel consumption = 60 km / l
j. Car fuel consumption = 11 km / l
k. Travel time from Sta. Png to destination = 10 minutes walk

b) Probability analysis of motor and KA

1) 1.2.1 Owners of motorbikes who use motorbikes

Monthly income = Rp. 3,000,000
Working hours per day = 6
days of work per week = 6
μ = 3,000,000 / (60 * 9 * 6 * 4)
μ = 231.48 Rp / min
% Using trains if already reactivated = 25%
p2 = 25%, then p1 = 77%
Mileage = 20 km
BBM = premium (Rp. 6,450 / ltr)
Fuel costs = (20km ÷ 60km / ltr) * Rp. 6,450
Fuel costs = Rp. 2,150
Travel time = 40 min.
Parking in own yard = 0 rp

GC = (40min * 1 * 231.48 Rp / min + Rp 2,150 + 0) * 2
GC = Rp 9,259.26 * 2
GC = Rp 22,818.52

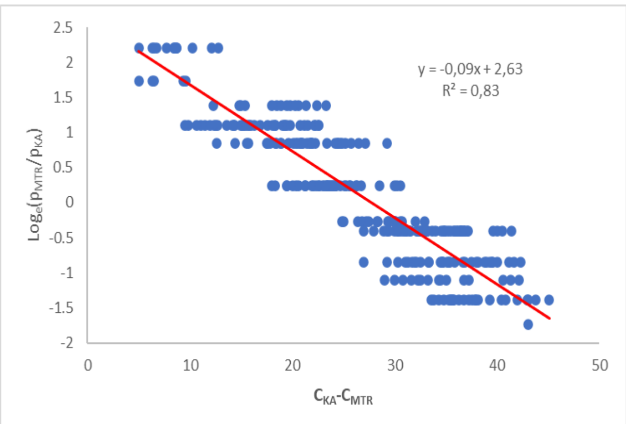
2) 1.2.2 Motorcycle owner when using KA

Monthly income = IDR 3,000,000
Working hours per day = 9
working days per week = 6
μ = 3,000,000 / (60 * 6 * 6 * 4)
μ = 231.48 IDR / min
% Using train if already reactivated = 25%
p_2= 25%, then p_1= 75%

Travel time to the station with mtr = 5 minto station with mtr = 5 min
Cost of travel time
* 1 * 231.48/ min
Rp= Rp. 1157.41
Parking fee = (length of work + 1 hour) * parkingParking feefee = (9 hours + 1 hour) * IDR 1,000
Parking fee = IDR 10,000
Waiting time at Sta = 5
minutes Waiting time at Sta = 5 minutes * 2,2 * 231,48Rp / min
Time fee wait in Sta = USD $ 2546.30
takes dg KA = 30mnt
travel time fee dg KA = 30mnt * 1 * 231,48Rp / min
travel time fee dg KA = USD 6944.44
Walk to the destination = 10mnt
Walk to your fee Destination location = 10min * 1.8 * IDR 231.48
Cost of walking to the destination = IDR 4,166.64

GC = (IDR 1157.41 + IDR 2,546.30 + IDR 6,944.44 + IDR 4,166.64) * 2 + IDR 10,000
GC = IDR 14,814.79 * 2 + IDR 10,000
GC = IDR 39,629,58
From the data above, it is known that
C1 (or CMTR) = IDR 22,818.52
C2 (or CKA) = IDR 39,629, 58
CKA-CMTR = IDR 16,811.06
p2 = 25%, then p1 = 75%
Then plotted:

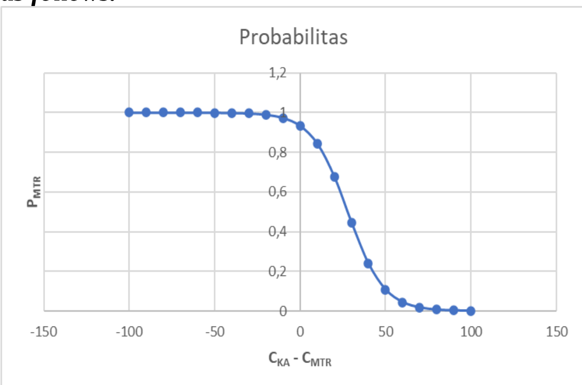
				LN(p1/p2)
No. Sampel	% Penggunaan (p)		$C_{KA} - C_{MTR}$	$\mathrm{Log}_e\{(p_1/p_2)\}$
	Motor (p_1)	KA (p_2)	(Xi)*1000	(Yi)
1			21,18	1,10
2			22,12	1,10
3			17,79	0,85
...				
...	75	25	16,81	1,10
...				
288			35,10	-0,85



No	TEST	RESULT	REMARKS
1	Linearitas	.000	Linear
2	Normalitas	.200	Terdistribusi normal
3	Heteroskedatisitas	.418	Tidak ada
4	Outlier	<1	Tidak ada

a = 2.63 or as βδ
b = -0.09 or as β
If, for example, C_{KA}-C_{MTR}= 100, then:

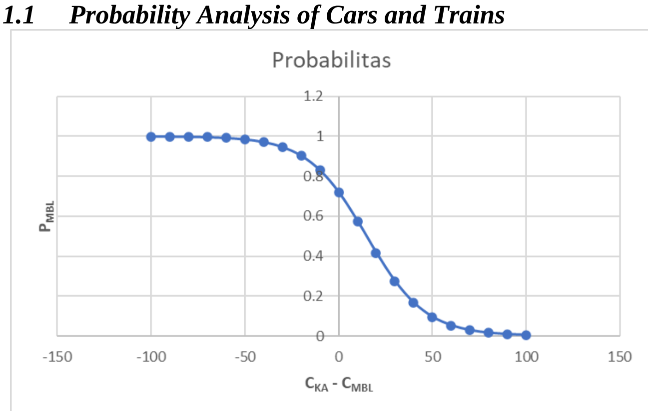
This analysis is then recalculated for the difference in cost (C_{KA}-C_{MTR}) starting from 90, 80, …, 0 to -100. The final results of the motor and KA probability analysis are as follows.



a. If C_{KA}-C_{MTR}= 0 or C_{KA}-0 = C_{MTR}, P_{MTR}= 0.93

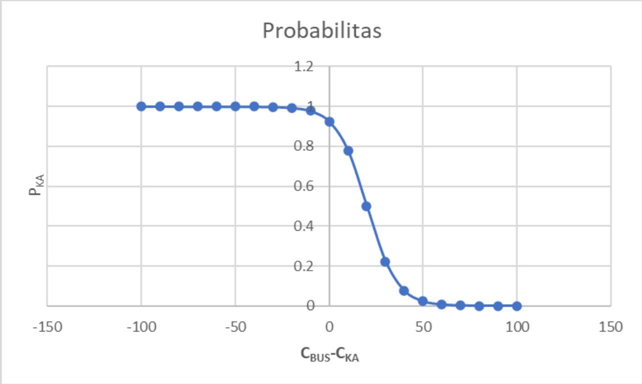
b. If C_{KA}-C_{MTR}= 10 or C_{KA}-10 = C_{MTR}, P_{MTR}= 0.84

1.1 Probability Analysis of Cars and Trains



a. If C_{KA}-C_{MBL}= 0 or C_{KA}-0 = C_{MBL} then P_{MBL}= 0.71
b. If C_{KA}-C_{MBL}= 10, OR C_{KA}-10 = C_{MBL}, then P_{MBL}= 0.57
c. If C_{KA}-C_{MBL}= 20, OR C_{KA}-20 = C_{MBL}, then P_{MBL}= 0.41

1.2 *Train and Bus Probability Analysis*



a. If C_{BUS}-C_{KA}= 0 or C_{BUS}= C_{KA}-0, then P_{KA}= 0.93

b. If C_{BUS}-C_{KA}= -10 or C_{BUS}= C_{KA}-10 then P_{KA}= 0.98

IV. CONCLUSION AND SUGGESTIONS

A. Conclusion

a. If the cost of transportation using train = motorbike, then the probability of using a motorbike is 93% (MTRàKA = 7%)

b. If the cost of transportation using a train is IDR 10,000 lower than that of a motorbike, then the probability of using a motorbike will be 84% (MTRàKA = 16%)

c. If the cost of transportation by train = car, then the probability of using a car is 71% (MBLàKA = 29%)

d. If the cost of transportation by train is IDR 10,000 lower than that of a car, then the probability of using a car will be 57% (MBLàKA = 43%)

e. If the cost of transportation by train is IDR 20,000 lower than that of a car, then the probability of using a car will be 41% (MBLàKA = 59%)

f. If the cost of transportation by train = bus, then the probability of using the train is 93%

g. If the cost of transportation by train is IDR 10,000 lower than using the bus, then the probability of using the train becomes 98%

B. Suggestions

a. To increase the probability of using the railway mode compared to the private vehicle mode, government intervention is required to reduce ticket costs and tariff costs. In this case, free parking rates and subsidized tickets are needed to reduce transportation costs by train. In the case of a significant difference in transportation costs between private vehicles and railway modes, it is necessary to pay attention to the engineering of private vehicle fuel rates to reduce transportation costs between the two.

B.With the slahung-madiun train operation, passengers who are captive riders, especially slahung-ponorogo, will mostly move from previous bus users to switch to train users without any engineering conditions. In the railway business, this condition is favorable. It is hoped that the said traffic service operators would continue to maintain the quality of their services to maintain bus passengers' loyalty who switch to become train passengers in the future.

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