

# The Correlation between Vehicle Age and Vehicle Operating Cost of Public Transportation in Banjar Regency

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## ABSTRACT

Public transportation operating in Banjar Regency is a type of mikrolet (microbus) serving urban and rural areas in Banjar Regency. The number of public transportation operating from year to year is continuously decreasing. The decreasing number of public transportation is caused by the operators' income, which is not as expected. One of the factors that influence operators' income is Vehicle Operating Cost. This research aims to analyze the correlation between the age of public transportation and the vehicle operating cost as well as to get the dominant variable influencing the vehicle life age. The method conducted in analyzing the correlation between the vehicle life age and the variable of vehicle operating cost is by carrying out regression and looking for the best equation. The data needed is in the form of primary and secondary data. Secondary data was obtained from the Banjar Regency Transportation Agency and primary data was obtained through interviews with drivers or public transportation owners. The results of this research indicate that there is a very strong correlation between the vehicle life age and the vehicle operating cost. The correlation between the vehicle life age and the VOC of public transportation in Banjar regency has a very strong at the age of  $\leq 25$  years with the value of 0.901 and at the age of more than 25 years with the value 0.995 with the two age groups forming an exponential equation. VOC variable due to increasing vehicle life age will be a very dominant influence on VOC when the vehicle is  $> 25$  years old, namely variables of fixed cost, depreciation cost, maintenance cost, and oil cost.

**Key Words:** Vehicle Operating Cost, Vehicle life age, Public Transportation.

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## 1. INTRODUCTION

Public transportation services have an important role in improving public transportation in various regions. Public transportation operating in Banjar Regency has decreased in number. The condition of the decline in the number of public transportation in operation shows that public transportation is not able to survive. Thus, a decrease in the number of public transportation always occurs in Banjar Regency every year. The decline in public transportation interest greatly influences the sustainability of public transportation which has an impact on decreasing income of transportation operators. The factors influencing the demand for transportation services include the prices of transportation services that include many kinds of costs, and not just the cost of transportation services [1]. One of the factors that influence operators' income is Vehicle Operating Cost. In PM 98 of 2013 [2] concerning Minimum Service Standards for Public transportation of Vehicles in Routes which came into force on 10 February 2015, it is stated that the age limit for Inter-city Inter Province (AKAP) and Intercity within province (AKDP) vehicles is regulated no later than 25 years or stipulated by the permit issuer in accordance with regional conditions so that the vehicle operates efficiently and economically. The effect of vehicle life age on the feasibility of operating city bus public transportation in Surakarta City to find out the life of passenger public vehicles that are still feasible to operate in terms of vehicle operating costs, especially city buses in Surakarta City [3].

## 2. LITERATURE REVIEW

## 2.1 Vehicle Operating Cost

According to the Decree of the Minister of Transportation No. KM. 89 of 2002 [4], concerning the mechanism for determining tariffs and formulas for calculating the cost of passenger transportation by public buses, grouping the basic costs of operating a vehicle according to its relation to the production of services produced is divided into:

### 1.1.1 Direct Cost

Direct costs are expenses that are directly related to the service products produced, which consist of fixed cost and variable cost. The calculation is that some of the costs can be directly calculated per km of vehicles, but some of the costs are calculated per km of vehicles after the annual cost has been calculated. Examples of direct costs are crew salaries, fuel, and terminal cost.

### 1.1.2 Indirect Cost

Indirect costs are expenses that are indirectly related to the service products produced, which consist of fixed cost and variable cost. The calculation cannot be directly per km of the vehicle because it contains components that are not directly related to the vehicle operation. Examples of indirect costs include: maintenance costs general/office costs, interest/money value costs, taxes.

### 1.1.3 Basic Cost

The basic cost per kilometer vehicle is calculated by summing direct costs and indirect costs. Vehicle operating costs (VOC) are the total expenses incurred by road users using certain modes from the origin zone to the destination zone. The total cost referred to is the actual cost incurred.

Vehicle operating costs consist of two components, namely fixed costs and variable costs [5].

a. Fixed costs are expenses which remain in expenditure without depending on the production volume that occurs. Fixed costs for passenger public transportation consist of 4 cost components, including:

#### 1. Vehicle Depreciation

Collecting money is a standard method used for vehicle replacement, done by setting aside a portion of the income earned during the lifetime of the vehicle. This money is referred to as depreciation costs. Depreciation costs can be treated as a component of fixed costs, if the lifetime of the vehicle is calculated based on time. To calculate depreciation costs, the first thing to conduct is to determine the price of the vehicle.

#### 2. Licensing and Administration

#### 3. Operator Salary

#### 4. Insurance

b. Running Costs are expenses incurred when the vehicle is operating. Variable costs vary greatly depending on the results produced. The cost components included in these non-fixed costs are: fuel cost, lubricant/oil usage cost, tire usage cost, repairs and maintenance costs.

Vehicle operating costs consist of the following components [6]: consumption of fuel oil, consumption of oil and lubricants, tire usage, vehicle repair and maintenance, depreciation, insurance, licensing fees for public transportation, wages from operators or drivers and driving license fees, garage rentals, bank interest rates for capital investment, supervision and unexpected costs.

## 2.2 Regression Analysis

Regression analysis is a study that involves the problem of finding correlations between variables. Correlations obtained are generally expressed in the form of equations and are called regression equations [7]. Regression analysis is useful for getting functional correlations between two or more variables. In addition, regression analysis is useful to get the influence between predictor variables on the variable criteria or predict the influence of predictor variables on variable criteria [8]. The results of the calculation of the regression analysis/test will be included in the research conclusions and will determine whether the research being carried out is successful or not. Simple linear regression is used only for one independent variable and one dependent variable, while multiple linear regression is used for one dependent variable and two or more independent variables [9]. Simple linear regression equation is an equation model that describes the correlation of one independent/predictor variable (X) with one non-free variable/response (Y), which is usually depicted in a straight line.

Correlation analysis is a study that discusses the degree of correlations between variables. Correlation coefficients are a measure of the degree of correlations especially for quantitative data named [7]. The strength of the correlation between predictor variable x and response y is measured by correlation analysis whose results are expressed by a number known as the correlation coefficient. Generally, regression analysis is often conducted together with correlation analysis. The correlation coefficient model as shown in Table 1 [10].

Table1. Interpretation of Correlation Coefficient

Absolute value of the correlation coefficients ( $ r $ )	Interpretation
0,00 – 0,199	Slight correlation; almost negligible correlation
0,20 – 0,399	Low correlation; definite but small correlation
0,40 – 0,699	Moderate correlation; substantial correlation
0,70 – 0,899	High correlation; marked correlation
0,90 – 1,000	Very high correlation; very dependable correlation

### 3. RESEARCH METHODOLOGY

#### 3.1 Data Required

##### 3.1.1 Secondary Data

Data is sourced from the Department of Transportation of the Banjar Regency.

##### 3.1.2 Primary data

Data is obtained directly in the field by means of surveys. The method used is a survey by interviewing public transportation owners and public transportation drivers.

#### 3.2 Stages of Data Analysis:

1. Transportation data in the form of vehicle life age and VOC.
2. Analysis of the correlation between VOC and vehicle life age.
3. If there is a form of equation with  $R^2 > 0.7$ , the equation can be used to show the correlation between VOC and the vehicle life age.

### 4. ANALYSIS AND DISCUSSION

The data taken was 55 respondents' data, then when the regression was conducted, it showed less good results so that the reduction of some data samples was carried out. The reduction was carried out because of incompatibility and incomplete data, then an analysis of 29 data was carried out.

#### 4.1 VOC Analysis

VOC analysis of urban/rural public transportation is by calculating the fixed costs and non-fixed costs incurred by the operator.

Components that are taken into account in calculating are: licensing costs, depreciation costs, maintenance costs, fuel costs, and operating costs.

Calculation Example:

For Route Code N, Route: *Martapura Kelampayan Ilir*, Distance of  $18 \text{ km} \times 2 = 36 \text{ km}$  (round trip)

1. Production Average Distance:
  - a. Vehicle operation per week = 7 days
  - b. Amount of trip per day = once (round trip)
  - c. Production distance per day = 36 km
  - d. Production distance per year =  $7 \times 1 \times 36 \times 48$   
= 12,096 km

Assumption: number of weeks in one year = 48 weeks

2. Fixed cost
  - a. Vehicle Tax Fee per year = IDR 262,000
  - b. Route License Fee per year = IDR 150,000
  - c. KIR (Motorized Vehicle Testing) Fee per year = IDR 170,000
  - d. Insurance Fee per year = IDR 240,000
  - e. Total Fixed Cost per year = IDR 822,000
  - f. Production distance per year = 12,099 km
  - g. Fixed fee per year (IDR/km) = IDR 67.9

3. Depreciation Cost

$$\text{Depreciation per year} = \frac{\text{price of a new vehicle} - \text{remaining value of the vehicle}}{\text{Economic Age}}$$

Vehicle residual value = Vehicle selling price – 20% of vehicle selling price

Economic life/useful life of *mikrolet* (microbus) = 5 years

Calculation Example:

The selling price of *mikrolet* now is IDR 16,500,000

Residual Value = 0.2 x 16,500,000 = 3,300,000,-

$$\begin{aligned} \text{Depreciation per year} &= \frac{130,000,000 - (16,500,000 - 3,300,000)}{5} \\ &= \text{IDR } 23,360,000 \end{aligned}$$

4. Maintenance Cost

a.	Engine oil cost per year	IDR	1,280,000
b.	Axle oil cost per year	IDR	600,000
c.	Fees for shipping per year	IDR	36,670
d.	Brake oil cost per year	IDR	40,000
e.	Platinum fee per year	IDR	35,000
f.	Condenser cost per year	IDR	35,000
g.	The cost of spark plugs per year	IDR	65,000
h.	Oil filter cost per year	IDR	25,000
i.	The cost of brake canvas per year	IDR	17,500
j.	Clutch plate fee per year	IDR	26,670
k.	Annual fee per year	IDR	216,670
l.	Front and rear wheel bearings per year	IDR	35,000
m.	Engine service cost per year	IDR	1,700,000
n.	Body service cost per year	IDR	1,100,000
o.	Vehicle washing per year	IDR	720,000
p.	Fee for tire replacement per year	IDR	760,000
q.	Total Cost per year	IDR	6,693,000
r.	Distance per year (km) = 12,096		
s.	Cost (IDR/Km) = 17/18	IDR	553,282

5. Fuel cost

a.	Vehicle operation per week	7 days
b.	Vehicle operation per year = 7 x 48 weeks	336 times
c.	Fuel consumption per day	5 liters
d.	Fuel consumption per year	1680 liters
e.	Annual fuel cost	IDR 11,004,000
f.	(Assuming that BBM = IDR 6,550/liter)	

6. Total of VOC

a.	Fixed cost per year	= IDR	822,000
b.	Depreciation cost	= IDR	23,360,000
c.	Maintenance cost per year	= IDR	6,693,000
d.	Fuel cost	= IDR	11,004,000
e.	Operating cost	= <u>IDR</u>	<u>16,800,000</u>
f.	Total of VOC per year	= IDR	57,958,500
	Total of VOC (IDR/km)	= IDR	4,792

Table2. Recapitulation of Variable Value of VOC (IDR/km)

No. Sample	Age	Maintenance Cost	Fixed Cost	Tired Cost	Fuel Cost	Oil Cost	Depreciation Cost	Total VOC
1	30	553	68	63	1000	162	1.931	1.110
2	29	441	56	55	656	137	1.611	1.170
3	28	447	49	50	708	130	1.297	1.210
4	27	358	35	73	786	99	960	1.211
5	26	209	25	27	678	70	685	1.218
6	25	216	23	47	737	53	592	1.187
7	25	216	19	34	696	70	493	1.209
8	24	187	20	20	655	63	490	1.210
9	24	146	20	15	737	55	490	1.198
10	23	155	23	39	737	44	486	1.232
11	22	143	21	17	737	54	483	1.261
12	21	166	22	35	737	33	479	1.236
13	20	159	21	34	655	56	483	1.248
14	20	213	36	39	614	61	476	1.237
15	19	148	23	22	614	58	472	1.257
16	19	125	22	17	614	32	476	1.339
17	19	122	36	20	614	32	476	1.319
18	18	130	24	17	614	42	469	1.403
19	16	116	27	22	655	31	462	1.384
20	16	132	24	20	614	48	462	1.401
21	15	102	24	6	614	43	458	1.392
22	14	117	25	22	614	35	455	1.351
23	14	115	25	22	614	49	455	1.424
24	13	96	25	20	614	28	451	1.567
25	13	127	25	22	614	52	451	1.596
26	12	123	26	20	614	50	448	2.139
27	12	122	26	30	614	29	448	2.501
28	12	81	27	15	614	40	448	2.763
29	9	83	23	16	655	45	350	3.462

4.2 Effect of Vehicle Life Age on the VOC

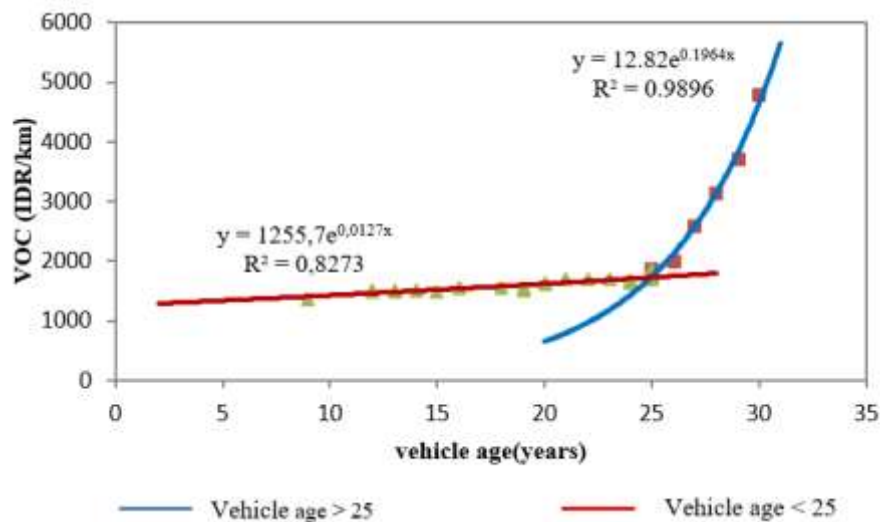


Figure1. Effect of Vehicle Life Age on the VOC

Figure 1 shows that the correlation between the vehicle life age and the total BOK, which is at the age of 0 to 25 years, has a very strong correlation, which is indicated by the value of  $R^2 = 0.8273$  or  $r = 0.901$  and there is a VOC increase of 1.3% per year. It is obtained that the equation  $y = 1255.7e^{0.0127x}$ . At the age of the vehicle above 25 years, it is obtained that the value of  $R^2 = 0.9896$  or  $r = 0.995$  can be defined that there is a very strong correlation and there is an increase in the VOC very rapidly, amounting to 21.7% per year. It is obtained that correlation equation  $y = 12,82 e^{0.1964x}$ . Where  $y$  = Vehicle Operating Cost (IDR/km) and  $x$  = vehicle life age (year).

### 4.3 Effect of Vehicle Life Age on the Fixed Cost Variable

Fixed cost variable is the cost incurred for payment of vehicle tax, fees for payment of route extension licenses, costs incurred for vehicle KIR payments, and costs for insurance services for one year in units of IDR/kilometers. Figure 2 shows the correlation between fixed costs and vehicle life age, which is at the age of vehicles 0-25. The effect of vehicle life age on fixed costs has a weak correlation, which is indicated by the value of  $R^2 = 0.1334$  or  $r = 0.365$  and the percentage of cost reduction is around 1.2% per year. In vehicles over the age of 25 years, there is a very strong correlation between fixed expenditure costs and the vehicle life age, which is indicated by the value of  $R^2 = 0.9733$  or  $r = 0.987$  and the percentage increase in costs is by 28.2% per year.

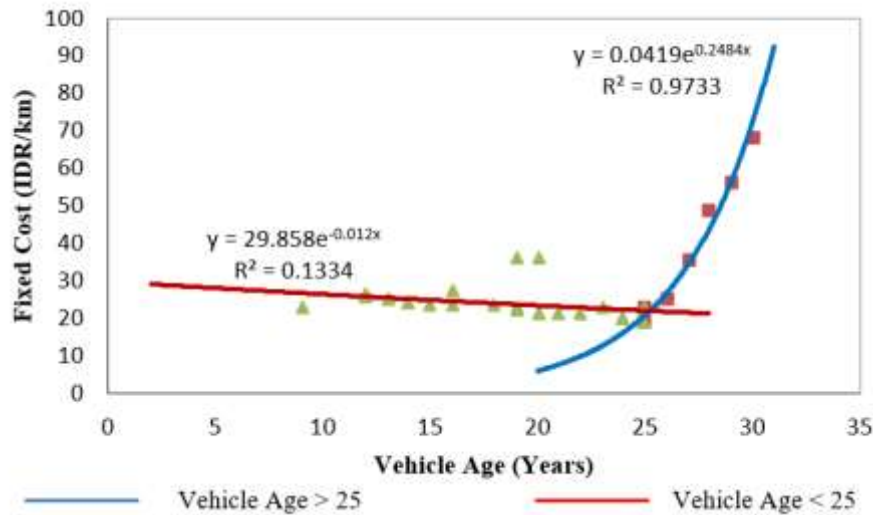


Figure2. Effect of Vehicle Life Age on the Fixed Cost Variable

### 4.4 Effect of Vehicle Life Age on the Depreciation Cost Variable

Variable depreciation costs are expenses that must be provided by the vehicle owner so that at the end of the economic life span, the vehicle owner can change his or her vehicle into a new vehicle. Figure 3 shows the correlation between depreciation costs and vehicle life age, which is at the age 0 to 25 years. The influence of vehicle life age on depreciation costs has a strong correlation, which is indicated by the value of  $R^2 = 0.6472$  or  $r = 0.804$  and the percentage increase in the average cost is by 5.4% per year. In vehicles over the age of 25 years, there is a very strong correlation between depreciation costs and the vehicle life age, which is indicated by the value of  $R^2 = 0.9825$  or  $r = 0.991$  and the percentage increase in the average cost is by 30.4% per year.

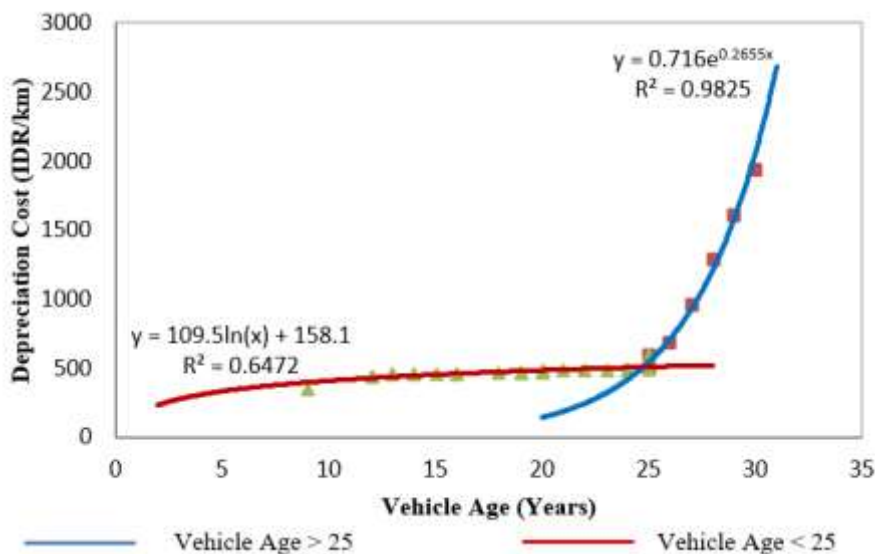


Figure3. Effect of Vehicle Life Age on the Depreciation Cost Variable

### 4.5 Effect of Vehicle Life Age on the Maintenance Cost Variable

The maintenance cost variable here is in the form of service and spare part costs. The variables included in the regression analysis are the cost of replacing parts such as tires, engine oil, axle oil, versatile oil, brake oil, platinum, condensers, spark plugs,

oil filters, brake canvas, clutch plates, batteries, front and rear wheel bearings, car wash costs, engine service costs, body service costs.

Figure 4 shows the correlation between maintenance costs and vehicle, which is at the age more than 25 years old. There is a strong correlation between the vehicle life age and maintenance costs, which is indicated by the value of  $R^2 = 0.7068$  or  $r = 0.8407$  and the percentage increase in maintenance costs is by 4.9% per year. In vehicles over the age of 25, there is a very strong correlation between the age of the vehicle and maintenance costs, which is indicated by the value of  $R^2 = 0.9114$  or  $r = 0.955$  and the percentage increase in maintenance costs is by 22.3% per year.

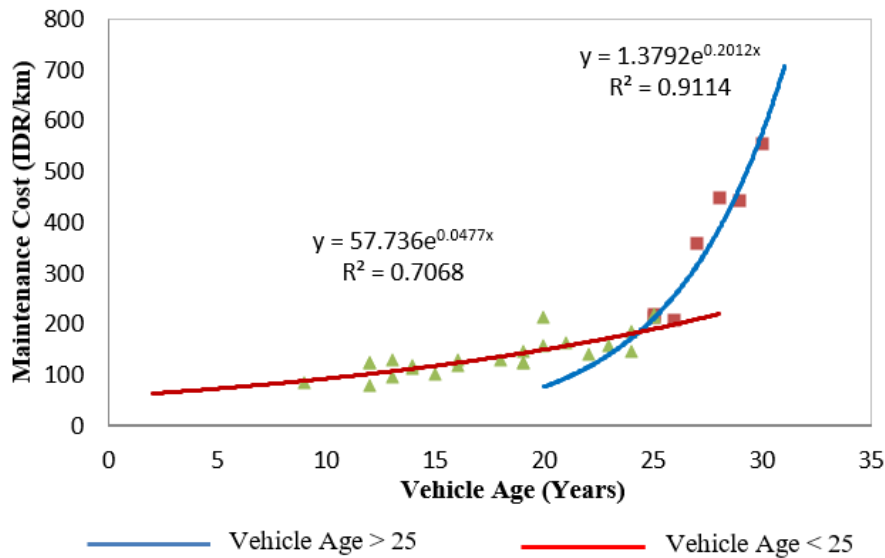


Figure4. Effect of Vehicle Life Age on the Maintenance Cost Variable

#### 4.6 Effect of Vehicle Life Age on Tire Cost Variables

Tire cost variable is the price of the costs incurred for tires, both inner and outer tires. Figure 5 shows the correlation between the vehicle life age and the tire cost. The result is a strong correlation between the age of the vehicle and tire costs. It can be seen from the value of  $R^2 = 0.4942$  or  $r = 0.703$  and the percentage increase in tire costs is by 9.7% per year.

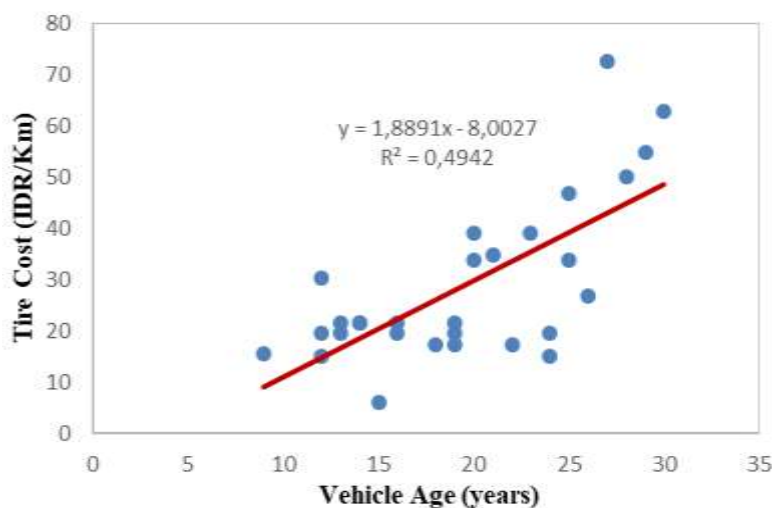


Figure5. Effect of Vehicle Life Age on Tire Cost Variables

#### 4.7 Effect of Vehicle Life Age on Fuel Cost Variables

Figure 6 shows the strong correlation between fuel costs and vehicle life age, which can be seen from the value of  $R^2 = 0.5226$  or  $r = 0.723$  and the percentage increase in fuel costs by an average is by 1.2% per year.

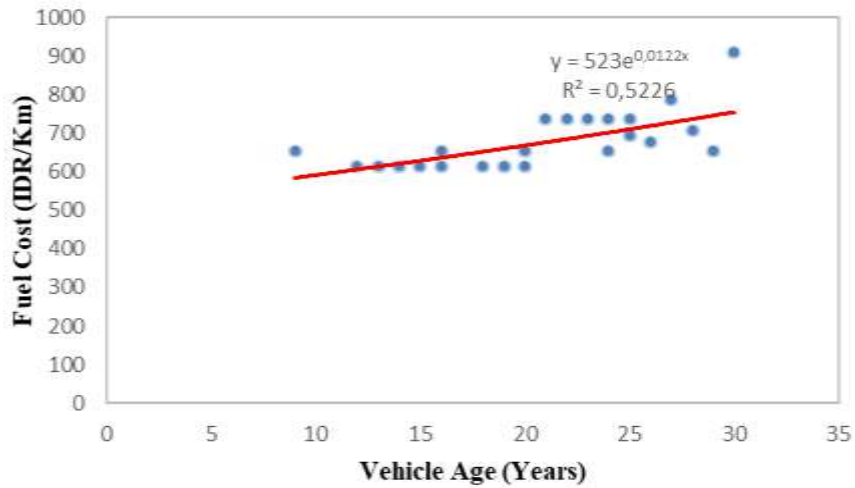


Figure6. Effect of Vehicle Life Age on Fuel Cost Variables

#### 4.8 Effect of Vehicle Life Age on Oil Cost Variable

Oil cost variable is the cost incurred for oil needs, namely engine oil, axle oil, gear oil and brake oil. Figure 7 shows the correlation between Vehicle life age and Oil Cost, that is, for vehicles that are up to 25 years old, there is a moderate correlation that can be seen from  $R^2 = 0.211$  or  $r = 0.458$  with a percentage increase in average costs of 2.6% per year. For vehicles over the age of 25, there is a very strong correlation between the vehicle life age and the oil cost, which can be seen from the value of  $R^2 = 0.9328$  or  $r = 0.966$  and the percentage increase in oil costs on average is by 22.9% per year.

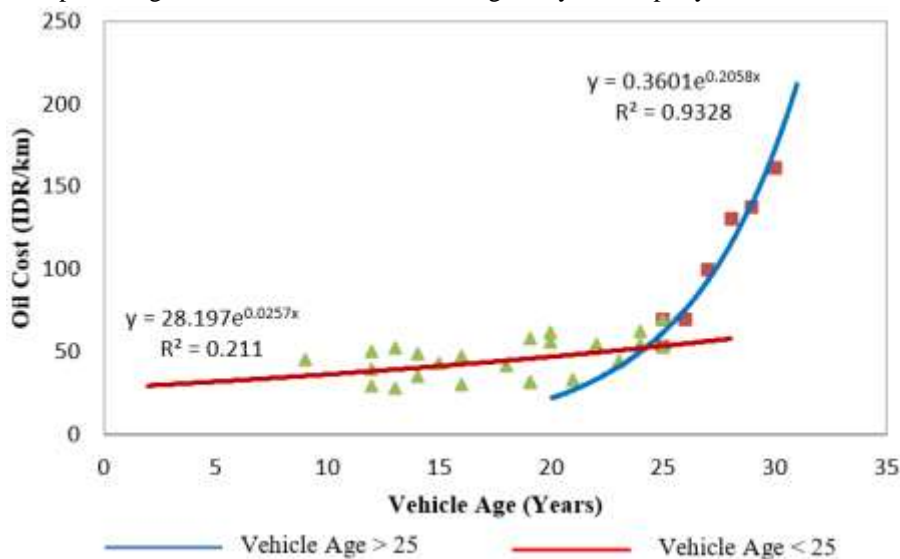


Figure7. Effect of Vehicle Life Age on Oil Cost Variable

#### 4.9 Average Production Distance

The average production distance is the distance traveled through by public transportation in one year in km unit. Figure 8 shows the correlation between the vehicle life age and the average distance of production. The result is that the average distance of production of public transportation will decrease along with the increasing age of vehicles. Until the age of 25 years, the average distance of production of public transportation decreases by 0.6% per year, but when it is more than 25 years, there is a tendency to decrease the average production distance of public transportation by 21.8% per year.



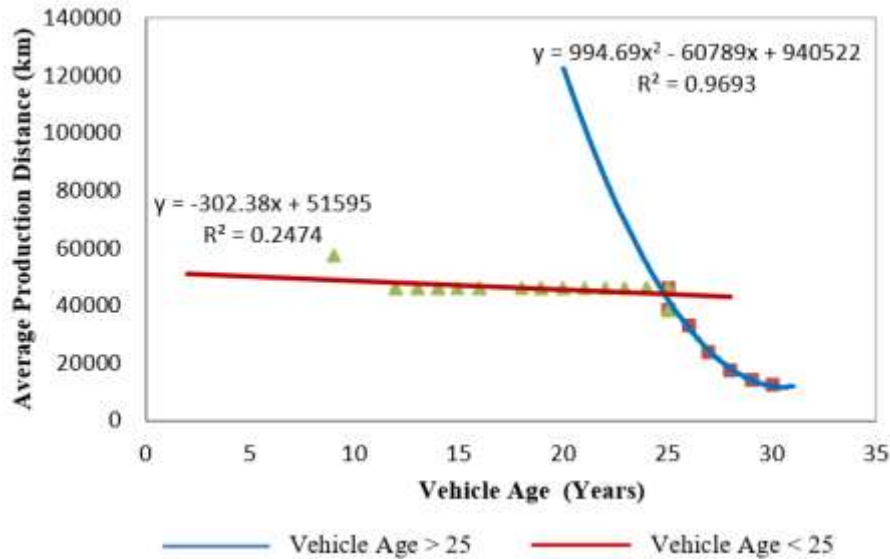


Figure8. Effect of Vehicle Life Age on Average Production Distance

5. DISCUSSION OF RESULT

Table3. Recapitulation of Correlation between Vehicle Life Age and VOC

No.	Variable	Model Equation	R <sup>2</sup>	r	interpretation	Sensitivity per year
1.	<b>VOC Total</b>					
	Age≤25	$y = 1255,7 e^{0,0127x}$	0,8273	0,901	Very High	1,27%
	Age>25	$y = 12,82 e^{0,1964x}$	0,9896	0,995	Very High	21,7%
2.	<b>Average Production Distance</b>					
	Age≤25	$y = -302,38x + 51595$	0,2474	0,497	Moderate	(-) 0,60%
	Age>25	$y = 994,69x^2 - 60789x + 940522$	0,9693	0,985	Very High	(-) 21,8%
3.	<b>Fixed Cost</b>					
	Age≤25	$y=29,858e^{-0,012}$	0,1334	0,365	Low	1,2%
	Age>25	$y=0,04196e^{0,2484x}$	0,9733	0,987	Very High	28,2%
4.	<b>Depreciation Cost</b>					
	Age≤25	$y=109,5\ln(x)+158,1$	0,6472	0,804	High	5,4%
	Age>25	$y=0,716e^{0,2655x}$	0,9825	0,991	Very High	30,4%
5.	<b>Maintenance Cost</b>					
	Age≤25	$y = 57,736 e^{0,0477x}$	0,7068	0,840	High	4,9%
	Age>25	$y = 1,3792 e^{0,2012x}$	0,9114	0,955	Very High	22,3%
6.	<b>Tire Cost</b>					
	Age 0-35	$y=1,8891x + 8,0027$	0,4942	0,703	High	9,7%
7.	<b>Fuel Cost</b>					
	Age 0-35	$y=523e^{0,0122x}$	0,5226	0,723	High	1,2%
8.	<b>Oil Cost</b>					
	Age≤25	$y=28,197e^{0,0257x}$	0,211	0,458	Moderate	2,6%
	Age>25	$y=0,3601e^{0,2058x}$	0,9328	0,966	Very High	22,9%

To observe the factors that influence the increase in VOC when the age increases, it is necessary to review the VOC determinant variables themselves, including:

- 1) Depreciation costs in this study are increasing along with increasing age. This is commensurate with the opinion of Oglesby [11] and Jinca [12] stating that the vehicle life age also affects the value of depreciation. The longer the age of the vehicle means the greater the level of shrinkage.

- 2) The maintenance costs in this study are increasing along with increasing age. This is commensurate with the research conducted by Handayani [3] in Surakarta stating that the increasing age of the vehicle means the more costs incurred for maintenance/replacement of parts. This is due to the increasing age of the vehicle, engine wear occurs so that to be able to work, it requires repairs by replacing damaged vehicle parts.
- 3) The tire cost in this research is increasing along with the age increase which is inversely proportional to the research conducted by Handayani [3] in which the increasing vehicle life age means the need for tires decreases because the vehicle is less frequently operated due to maintenance. In this research, there may be other factors that influence tire usage. Because according to Morlok [13], tire usage is influenced by vehicle speed, road slope, type of vehicle, type of road and road alignment.
- 4) The use of fuel will increase along with age, in this research, fuel consumption increases slowly and has a strong correlation. This is in line with the opinion of Oglesby [11] stating that vehicle life age is also a factor that affects vehicle fuel consumption. The increase in fuel use is not too significant, because maintenance or modification of the engine has been made so that the use of fuel in terms of the trend is not significant.
- 5) Oil/lubricant costs in this research are increasing along with increasing age, especially after age above 25 years, this is commensurate with the research conducted by Handayani [3] in Surakarta stating that the more vehicles age means the greater consumption of lubricants. This is due to the increasing age of the vehicle, engine wear occurs so that to be able to work, it requires repairs by replacing damaged vehicle parts.
- 6) Judging from the production distance at the age under 25 years, the production distance is almost the same except after at the age above 25 years, there is a very extreme decline. This is because at an old age, it takes time for repairs and maintenance, and the operators see the number of passenger requests and if the number of passengers is inadequate, the transportation is usually not operating.

Judging from the interpretation of the correlation between the vehicle life ages, it is found that the older the vehicle life age means that the overall VOC will be even greater. This is because the value of the dominant variable affecting the value of the VOC is also getting bigger or rising up. By observing the correlation between the vehicle life age and operating costs, it can be seen that the age of public transportation is efficiently operating in terms of vehicle operating costs.

## 6. CONCLUSION

From the results of calculations and analysis of survey data, it can be concluded that the correlation between the vehicle life age and the VOC of public transportation in Banjar regency has a very strong correlation at the age of  $\leq 25$  years with the value of  $r = 0.901$  and the equation  $y = 1255.7 e^{0.0127x}$  and at the age of more than 25 years with the value of  $r = 0.995$  and the regression equation  $y = 12.82 e^{0.1964x}$ , where  $y$  is VOC and  $x$  is the vehicle life age. The value of VOC due to the increase in age of the vehicle is that at the age of  $\leq 25$  years, the VOC rises slowly in each age increase with an average percentage increase of 1.7% per year whereas at the age of 25 years. The value of VOC rises drastically with an average percentage increase of 14.5% per year for each age of motorized vehicles. VOC variable due to increasing age of the vehicle will be a very dominant influence on VOC when the vehicle is  $> 25$  years old, namely variables of fixed cost (licensing), depreciation cost, maintenance cost (service and spare parts), and oil cost.

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