Study of Road Maintenance Costs in Makassar City for National Roads and Provincial Roads

M. Asad Abdurrahman, Irwan Ridwan Rahim, M. Kurniawan Amir

Abstract: The lifetime of a street road is highly depending on the existing traffic and environmental conditions. Eventually the road may experience damage and decreases in condition caused by the heavy vehicles. Thus, the road requires schedule to maintain for better sustainability. The budget allocation for road maintenance and road improvement is crucial and high accuracy of budget estimation is required. This study used multiple regression analysis to develop a model with two independent variables, area of road and Average Daily Traffic volume (ADT) to determine the road maintenance budget in 2014 on the national roads and provincial roads in the city of Makassar.

Keywords: ADT, Budget allocation, Multiple regression analysis, Road maintenance.

I. PRELIMINARY

A road is expected to have a longer service lifetime for about 10 to 20 years, depending on the existing traffic and environmental conditions [1, 2]. Practically, the road condition may decrease as its experience stress and damage especially by heavy vehicles [3]. It is necessary to carry out road maintenance in order to slow down the rate of decline in road conditions and the road can still function in accordance with the planned useful life [4, 5].

Maintenance and rehabilitation of damaged road require a lot of money. Cost estimates play an important role in the implementation of construction projects [6]. Estimation activities are one of the main processes in construction projects to determine the amount of funds that must be provided for the particular planned project. Hence, any inaccuracies of cost estimation that occur will have an adverse effect on the involved parties [2]. The project owner needed to comply with the policy, especially on the cost estimation section, because cost estimation is important to determine the amount of investment.

In the implementation of construction practices, several different estimates are needed to consider based on the intended use and allotment [7, 8].

In the early stages of planning a road maintenance project, the overall estimation cost is not completed. It is clear that estimates are not possible based on the calculation of the quantity (volume) of the work because the description and specifications of the work have not been arranged [2]. Therefore, the project owner requires cautious cost estimation in order to prepare the project budget.

Meanwhile, the primary criteria in the cost estimation model during the early stages of project planning are fast estimates, easy to use, accurate and produce reliable estimation [9]. The national roads and provincial roads in the city of Makassar are considered in this study. An effective cost estimation technique was developed to estimate and analyse the cost of road maintenance budget at the early stage of project planning.

II. METHODOLOGY

There are 12 national road sections and 5 provincial road sections in Makassar City are considered in this study. The considered road name is shown in Table 1. The cost estimates and analysed in this study are based on the processed data which obtained from previous related studies and relevant agencies.

This study involved two independent variables and one dependent variable. The independent variable is the variable that changes independently and influences the dependent variable. The relationship between the variables is shown in Figure 1. Here, the independent variables are Area of Road and Average Daily Traffic volume (ADT). The dependent variable is the road maintenance budget.
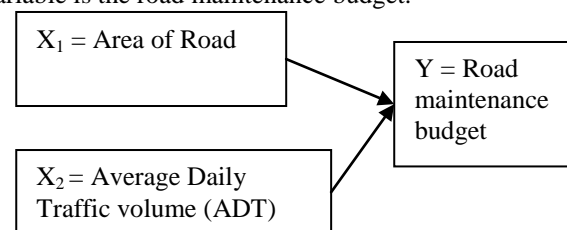
Fig. 1 Relationship between independent variables and dependent variables

In this study, data analysis was performed using regression analysis. Regression analysis is a process of systematically estimating what is most likely to occur in the future based on the current information and held to minimize errors.

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Regression analysis can be used to predict the change by varying the variables. The developed equation from regression analysis is a solution to make predictions. Thus, regression analysis is often referred to as predictive analysis.

III.   RESULTS AND DISCUSSION

The increases number of vehicles from year to year eventually saturates the traffic of some main roads in Makassar City. The maintenance distance on selected roads is highly depending on the road structure and traffic density. Table 1 illustrates the road`s length and the maintenance distance from year 2012-2014.

The maintenance cost, and improvement of national roads are funded by the Nation budget (APBN), while the maintenance cost, and improvement of provincial roads are funded by the Provincial Budget (APBD). The annual maintenance and road improvement of national roads are conducted by PPK21 of Makassar City, while PPTK responsible for the provincial roads. The cost of annual

maintenance and road improvement are affected by the several numbers of work items especially the road damage.

The recapitulation of the annual budget for annual maintenance of national roads and provincial roads in Makassar City is shown in Figure 2. Each national and provincial road section has a different maintenance budget and blue budget is depending on the level of damage and type maintenance required to carry out.

There are several factors that may influence the road maintenance cost in Makassar City. In this study, the annual maintenance budget in 2014 used as variable Y. The area of road which calculated from the multiplication of length and width of the road is defined as variable X1, while the Average Daily Traffic volume (ADT) is defined as X2.

Microsoft Excel program is used to execute the regression analysis with 95% of confidence interval. The obtained R square value is 0.8978 which very close to one and indicate the model is valid and has higher prediction. Table 2 and Table 3 illustrate the result of regression analysis and the ANOVA test for regression analysis respectively.

Table. 1 Road Maintenance Data (2012-2014)

NO	Road Name	Distance of Road (km)	Maintenance Distance (km) by Year		
			2012	2013	2014
	National Roads				
1	Jl. PerintisKemerdekaan	12.51	10.51	10.51	8.51
2	Jl. UripSumiharjo	4.943	4.94	4.94	4.82
3	Jl. Bulusaraung	0.675	0.68	1.1	0.67
4	Jl. GunungBawakaraeng	1.11	1.11	0.68	1.11
5	Jl. Mesjid Raya	1.224	1.22	0.7	1.2
6	Jl. Ahmad Yani	0.7	0.7	0.23	0.7
7	Jl. Nusantara	1.942	1.94	1.94	1.93
8	Jl. Veteran Utara	2.074	2.07	2.07	2.07
9	Jl. Veteran Selatan	2.158	2.16	2.16	2.14
10	Jl. Sultan Alauddin	3.702	3.7	3.7	1.3
11	Jl. Riburane	0.23	0.23	1.22	0.23
12	Jl. A. P. Pettarani	4.37	1.5	1.32	2.79
	Provincial Roads				
13	Jl. Jend. Sudirman	1.34	1.34	1.34	1.34
14	Jl. Dr. Ratulangi	2.07	2.07	2.07	1.47
15	Jl. Dr. Leimena	2.7	2.15	0.9	2.7
16	Jl. Antang Raya	1.5	1.5	1.5	1.5
17	Jl. Tamangapa Raya	3.36	3.36	1.86	2.36
	TOTAL	46.608	41.18	38.24	36.84

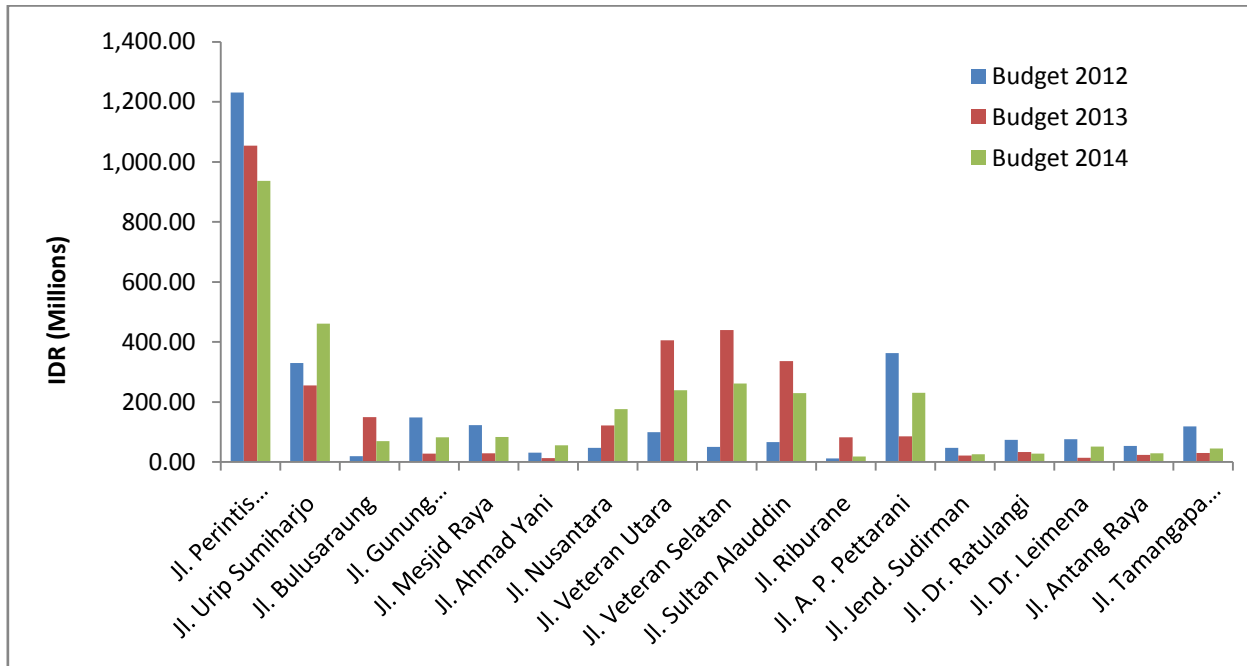Source: SNVT PelaksanaanJalanNasional Metropolitan Makassar and DinasBinaMargaProvinsi Sulawesi Selatan (2014).

Fig. 2 Comparison of maintenance budget for annual maintenance in 2012-2014

Source: SNVT PelaksanaanJalanNasional Metropolitan Makassar and DinasBinaMargaProvinsi Sulawesi Selatan (2014).

Table. 2 Results of regression analysis

	Coefficients	Standard Error	t Stat
Constant	58553532.99	34742084.28	1.685377668
Area of road	2731.738193	292.1030009	9.351968946
Average Daily Traffic volume (ADT)	-143983.6118	89424.47318	-1.610114174

Table. 3 Results of ANOVA test for regression analysis

	df	SS	MS	F	Significance F
Regression	2	7.57907E+17	3.78954E+17	61.49071002	1.16484E-07
Residual	14	8.62789E+16	6.16278E+15		
Total	16	8.44186E+17			

Based on the results of multiple regression analysis, the relationship between the variables can be express in equation (1.0). Y symbolized the road maintenance cost for the year 2014. X1 and X2 in the equation represent the independent variables of area of road and ADT respectively. While, the obtained regression coefficient for the constant value is 58553532.99, the value of b and c is 2731,738 and 143983,611 respectively. Therefore, the relationship between the maintenance budget in the year 2014 and area of road as well as ADT is expressed in the equation (2.0).

$$\hat{Y} = a + bX_1 + cX_2 \qquad (1.0)$$

$$\hat{Y} = 58553532.99 + 2731.738X_1 + 143983.611X_2$$

$$(2.0)$$

The obtained multiple regression equation indicated that when both variables X1 and X2 equal to zero, the road maintenance budget increased by Rp. 58,553,532.99 for the following year. Thus, any increase in the road area of 100 m2 will increase the road maintenance budget by Rp. 273,173.80 for the following year. Also, any increase in road ADT of 10 pcu / day will reduce the road maintenance budget by Rp. 1,439,836.11 for the following year.

The results of the analysis show that there is a fairly high correlation between the area of the road and the ADT of the road on the maintenance budget for the following year. Thus, it can be seen that the more extensive the road and the lower the ADT value of the road, the greater the road maintenance budget are needed. The obtained equation model is used to compare the results with the annual maintenance budget 2014. Figure 3 compared the 2014 road maintenance budgets with the regression model.
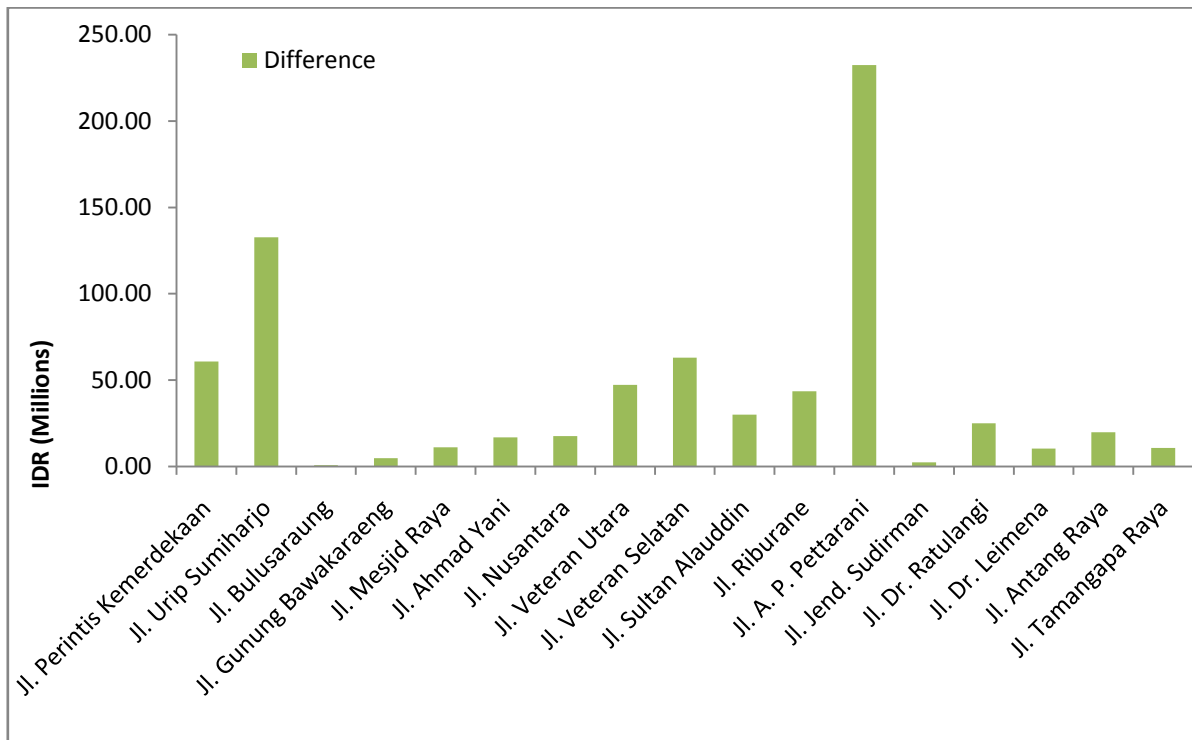
Fig. 3 Comparison between the 2014 road maintenance budgets with the regression model

IV. CONCLUSIONS

This study has developed an effective cost estimation technique to determine the road maintenance budget at the early stage of project planning. Therefore, the following year road maintenance budget of the National Road and Provincial Roads in Makassar City can be estimates based on the obtained multiple regression equation.

ACKNOWLEDGEMENT

The author extends the appreciation to Civil Engineering Department, University of Hasanuddin for unconditional support.

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