Comparison of Road Improvement and Maintenance Costs Before and During the Covid-19 Pandemic (Case Study in Karanganyar Regency, Central Java)

Triyanto[1(✉)], Sri Sunarjono[2], Zihardi Idris[2], and Nurul Hidayati[2]

[1] Office of Public Works, Kabupaten Karanganyar, Central Java, Indonesia
triantosatu4@gmail.com

[2] Master of Civil Engineering, Universitas Muhammadiyah Surakarta, Surakarta, Indonesia

Abstract. Limited costs are the main issues in road handling, as well as delays in maintenance, inefficient allocation of costs and problems related to implementation are the causes of road damage. The purpose of this study was to determine the comparison of the cost of improvement and maintaining, especially the Karanganyar Regency Road before and during the Covid-19 pandemic. The research method uses a quantitative approach, involving road sections that are the authority of the district in the population of 457 road sections, and is studied in this study as a sample with a sampling technique in total sampling. Secondary data in the form of survey results of district road sections through the Surface Distress Index (SDI) and data on standard unit prices of road handling activities for the 2012–2021 period at the Karanganyar Regency Public Works and Public Housing Office. Data analysis techniques are carried out with descriptive statistics. The results showed that the linear model was used to assess the comparison of district road handling costs before and during the Covid-19 pandemic, where the cost of improvement roads obtained a linear model equation $Y = -3E + 09X + 6E + 12$ with a negative (decreasing) trend, while maintenance costs produced a model formula equation $Y = 3E + 08X - 7E + 11$ with a positive linear trend (increasing), from the description shows the difference in trend between the cost of improvement and cost maintenance with a fluctuating cost pattern on an annual basis.

Keywords: Road Improvement · Maintenance costs · COVID-19

1 Introduction

The Public Works and People's Housing Office (DPUPR) of Karanganyar District, instructed those district roads in Karanganyar Regency in dealing with damage to district road infrastructure allocate a budget divided into two types of handling programs, namely costs for road improvement and costs for road maintenance [1]. Road improvement costs are activities to allocate funds needed to realize the program's goal of improving the ability of road sections in unstable or critical conditions so that the road sections are in stable

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condition following the life of the plan, while road maintenance costs are the activity of allocating funds to realize program goals in the form of prevention, maintenance and repairs needed in maintaining road conditions to continue to function optimally serve traffic so that the life of the set plan can be achieved [2].

Road handling activities in the form of improvement and maintenance at available costs are needed to make road maintenance more effective and efficient based on various criteria that represent the condition of the area [3]. However, the efforts made related to the cost of dealing with road conditions at the district level are mostly ineffective, for example, the problem of effectiveness between cost and handling, namely, in 2020 the Sergai Regency PUPR Office as a user cost more than 1 billion for road improvement is seen that the project is carried out, not following the RAB, working drawings and specifications. Then the Ciamis Regency PUPR Office in road improvement and maintenance work with a large cost was backgrounded by the weak supervisory function of the relevant agency as the project owner, as a result of which many physical works were not following specifications and were not optimal. Furthermore, the Clan Development Office of the Klaten Regency government worked on improvement a 1 km road that cost more than 2 billion more with perfunctory results [4]. The problem faced by the Karanganyar Regency government regarding the costs for handling roads at the district level is not only in the availability of costs, but also the proposals for road improvement and maintenance in 2020 and 2021 cannot be fully worked out, due to limited costs. Limited costs are caused by refocusing (reconcentrating) costs for handling Corona Virus Disease (Covid-19 pandemic).

Reliable transportation services for the road sector can be translated into regional connectedness and stability of road services. The road stability target for regional roads is specifically mentioned to increase the stability of provincial roads to 80%, and district/city roads to 70%. To maintain the achievement of increasing the road stability target in this area, technically increasing the stability of this road must be considered as a reward in the technical criteria for allocating DAK [15]. To help regions with this funding limit, the government budgeted a Special Allocation Fund (DAK), which is a fund sourced from the State Budget [16].

Based on the description above, it is hinted that these two costs are very important because to know the trend between the cost of improvement and maintenance costs, especially the Karanganyar Regency road before and during the Covid-19 pandemic, of these two costs so it is necessary to review the costs that have been carried out in the last 10 years because these costs will be able to be utilized and are very useful for guidance/guidelines for cost formulation policies in the years ahead.

2 Literature Review

2.1 Road Improvement

Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia Number 03/PRT/M/2015 concerning the Use of Special Allocation Funds for Infrastructure, defines road improvement as a handling activity to be able to improve the ability of road sections in unstable or critical conditions so that these road sections are in stable condition following the age of the plan. Capacity building is the handling of

roads with pavement widening, either increasing or not increasing the number of lanes. To optimize the assistance of the Road Subfield DAK, road improvement activities in the form of road widening must meet the minimum requirements for traffic lane width, namely 5.5 m for local/district roads and 7 m for provincial roads. Road widening work that exceeds the above provisions must be accompanied by a technical justification, and obtain approval from the local SNVT P2JN [5].

Road upgrades are generally necessary to improve the integrity of pavement structures, that is, to increase their structural value by providing structural additional layers. Road improvement are carried out, either because their service life is up, or because of initial damage caused by outside factors such as weather or due to planning errors or the implementation of reconstruction [6]. Road improvement work consists of work on structural improvement of road pavement, road widening work and geometric repair of roads on sharp turns. Improvement work is carried out if periodic maintenance work is carried out too late so that the road damage that occurs has affected the foundation. The road maintenance and rehabilitation phase are associated with roads that have a "steady" level of service, while improvement and support are associated with roads that have "unstable" service levels and "critical" roads [7].

The criteria used in the district road improvement program in this study refer to the Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia Number 03/PRT/M/2015 [5], Zulkifli [7], as well as conditions in the field including road conditions, LHR, road length and community demands. *Sample Heading (Forth Level).* The contribution should contain no more than four levels of headings. The Table 1 gives a summary of all heading levels.

2.2 Road Conditions

Road conditions are indicated by the percentage of damage to district road pavements [9]. Indications that indicate a decrease in road conditions are the occurrence of road damage, both functional damage and structural damage can vary which can be seen from the form and process of occurrence and causative factors such as traffic and non-traffic factors [2].

The government is putting greater pressure on road administration to improve the efficiency, and accountability, of road network management [10]. One of the policies for road implementation in the district is the strengthening of existing road conditions through maintenance and rehabilitation [2]. The relationship between the condition and accumulated load of the vehicle is visualized in the Fig. 1.

Due to traffic conditions and other non-traffic conditions, the road will experience a decrease in the condition indicated by damage to the road pavement surface. The decrease in conditions results in the road's ability to support compulsive axis loads decrease (line A) or in other words the life of the road pavement plan will be reduced. Meanwhile, line B shows the influence of maintenance activities, namely slowing down the level of road damage (point 1) and improving conditions close to the initial condition (points 2 and point 3). Maintenance that is done well, will keep the road from becoming damaged so that road users will experience comfort in driving vehicles. Conversely, if maintenance is not done properly, it will result in the road being damaged quickly and road users will pay more for vehicle repairs and fuel use [2].

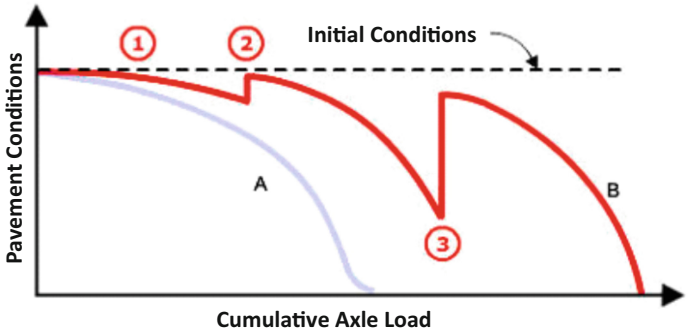

Fig. 1. Relationship of Vehicle Condition and Load Accumulation Source: DPU-BPP-Puslitbang Prasarana Transportasi, 2005

If the handling funds are limited then, routine maintenance becomes the first handling for all road sections, then periodic maintenance becomes the second handling for road sections that are currently in moderate condition, then road improvement become the third handling for road sections that are currently in a damaged condition and if funds are sufficient for reconstruction becomes the fourth/last handling for road sections that are currently in a severely damaged condition [11].

3 Methodology

3.1 Research Design

This type of research is descriptive quantitative which is exploratory. Research with a quantitative approach because research relies on quantitative data types or inferential statistical techniques. The road sections that are the authority of the district in the population are 457 roads and were studied in this study as samples with total sampling techniques.

3.2 Data Retrieval

Secondary data in the form of survey results of district road sections through the Surface Distress Index (SDI) and data on standard unit prices of road handling activities for the 2012–2021 period at the Karanganyar Regency Public Works and Public Housing Office. Data analysis techniques are carried out with descriptive statistics.

4 Result and Discussion

4.1 Country Road Handling Costs

Handling activities that are allowed in the use of DAK sourced from the State Budget are periodic maintenance activities, rehabilitation, improvement and completion of development [5]. The following data on the cost of handling roads in Karanganyar Regency for a period of 10 years is presented in the Table 1 [12]:

Table 1. Karanganyar Regency Road Handling Cost Data for the 2012–2021 Period

No.	Years	Handling Type	Cost (Rp)
1	2012	Inprovement	36.103.580.250
		Maintenance	5.340.000.000
2	2013	Inprovement	41.112.304.000
		Maintenance	5.780.000.000
3	2014	Inprovement	71.296.986.500
		Maintenance	4.500.000.000
4	2015	Inprovement	40.245.101.500
		Maintenance	10.524.190.600
5	2016	Inprovement	145.329.621.575
		Maintenance	12.881.267.300
6	2017	Inprovement	105.595.000.000
		Maintenance	8.550.000.000
7	2018	Inprovement	54.474.162.000
		Maintenance	13.615.965.000
8	2019	Inprovement	75.844.325.000
		Maintenance	11.640.346.000
9	2020	Inprovement	8.856.000.000
		Maintenance	7.647.000.000
10	2021	Inprovement	8.090.680.000
		Maintenance	5.585.000.000

Source: DPU PR for Clan Development in Karanganyar Regency, 2021

Technically, the trend of the cost of improvement and maintaining district roads in 2020 and 2021 tends to be smaller when compared to previous years. In those two years, there were limited costs caused by refocusing costs for handling the Covid-19 pandemic. According to Ray, delays in maintenance, lack of costs, inefficient allocation of cost expenditures and problems associated with implementation are the causes of road breakdowns [13]. Problems that exist in the road sector include a transportation network system that has not been integrated, inadequate regional road conditions and limited costs. The main issue in road handling is the limited costs it has to handle all road sections within its authority [17]. Sunarjono and Nyoto added that improper handling results in pavement being easily attacked by premature damage so that its service life is reduced very significantly [14].

4.2 Country Road Upgrade Costs

The cost of upgrading district roads in Karanganyar Regency in the last 10 years, namely from 2012 to 2021, can be visualized in Fig. 2.

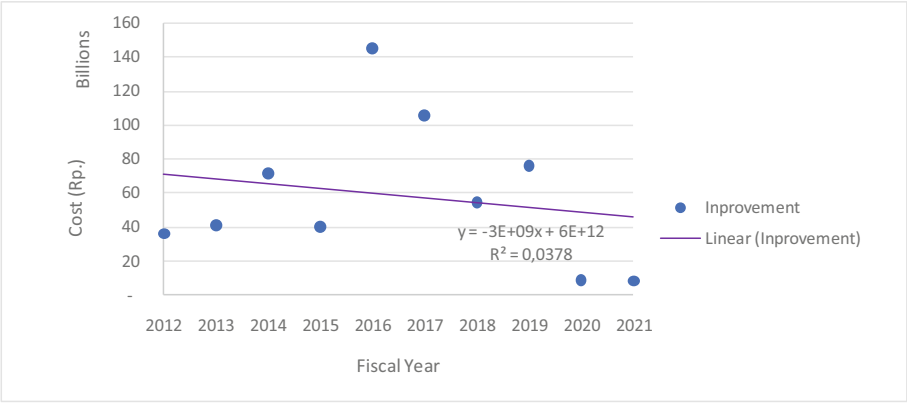

Fig. 2. Karanganyar Regency Road Improvement Cost Trend

Figure 2 shows that the cost of improvement district roads tends to fluctuate from year to year with the highest cost of road upgrades in 2016 of 145,329,621,575 rupiah when compared to other years, this is because the year coincides with the agenda of accelerating the development of regional road infrastructure so that there is a very significant absorption of funds. Meanwhile, in 2020 and 2021, the lowest cost was around 8 billion, in those two years, there was a pandemic which caused the cost of infrastructure development, especially road increase, to be reduced a lot for emergency handling of the Covid-19 pandemic.

The ten-year (2012–2021) upward trend is negative with the model equation $Y = -3E + 09X + 6E + 12$. This indicates that the cost trend has increased over the past ten years with a declining pattern. The results of this study are in line with Andjioe's research, that the allocation of large costs in road construction/improvement programs will always give a significant improvement to the steady condition of roads, but it is not proven in this study [18]. To overcome a large amount of road damage with limited costs in each area, the technical agency in this case the Public Works Department must have a clear analysis to divide these limited costs in the road construction/improvement program.

4.3 Country Road Maintenance Costs

In this section, the cost of maintaining district roads in Karanganyar Regency is presented in the last 10 years, namely from 2012 to 2021 as shown in Fig. 3.

Road maintenance costs (Fig. 3) result in the model $Y = 3E + 08X - 7E + 11$, this model is defined as a positive linear trend in which maintenance costs over the past ten years with an increasing pattern. Although cost fluctuations continued to occur during the ten years, 2018 was the culmination of handling road maintenance in good and moderate condition, while cost limitations remained, so that the maintenance costs required were higher than the years before and after which accounted for 13,615,965,000 rupiahs. According to Wahyudiana, if the handling funds are limited, routine maintenance

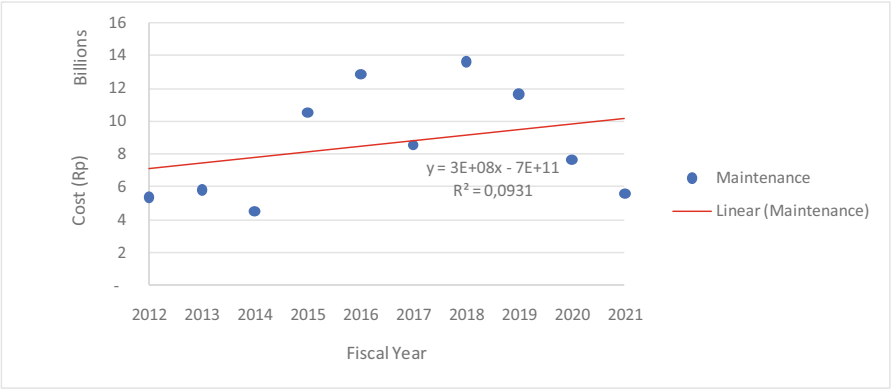

Fig. 3. Karanganyar Regency Road Maintenance Cost Trend

becomes the first handling for all road sections, and then periodic maintenance becomes the second handling for road sections that are currently in moderate condition [11].

Research conducted by Ekwueme et al. concluded that the regression model for estimating maintenance costs can be updated automatically according to price conditions. The regression model can be used as a guide for cost planning and capital allocation in continuous maintenance and has achieved good results in its application, making it worthy of promotion in other areas [19]. Furthermore, Zukhruf et al. in their research suggest that linear models can plan multi-year maintenance activities with budget constraints. In addition, determining the optimum budget allocation can also be generated by considering the performance to be achieved through simulating budget constraint scenarios [20].

5 Conclusion

The linear model is used to assess the comparison of district road handling costs before and during the Covid-19 pandemic, where the cost of improvement roads obtained a linear model equation $Y = -3E + 09X + 6E + 12$ with a negative (decreasing) trend, while maintenance costs produce a formula model of the equation $Y = 3E + 08X - 7E + 11$ with a positive linear trend (increasing), from the description shows the difference in trends between the cost of upgrading and maintenance costs with a pattern of fluctuations in cost fluctuations every year.

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