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Abstract. Start at present, investment in toll road construction is conventional investment in the form of investment within a certain period of time to obtain profits from the results of capital loans / financing obtained from toll revenues during toll road operation during the concession period by the BUJT. This means that BUJT has full authority over the implementation of road maintenance at the location of its concession. Hence toll road concessions have the obligation to maintain toll roads in accordance with minimum service standards using the company's toll road revenues. Thus, each BUJT has their own maintenance policy. Therefore, the management of toll roads that are managed on a concession basis can lead to differences in road damage management programs in each BUJT concession. This research assesses the road maintenance program planning on BUJT toll road concession holders to see the effectiveness BUJT in carrying out road maintenance regarding of the fulfillment of SPM. The result shows that the majority of BUJT has regularly carried out efforts to improve road functions, however they have the inadequacy in conduct conditions surveys by using equipment according to the standards. with "Undertake routine efforts throughout the year to maintain road conditions" being the highest mean whereas "Perform visual assessment on foot" has the lowest mean value. Moreover, it can be determine that the road damage frequency data found is with the an "Adverse Opinion" audit findings result that is conducted by BPJT with the most frequent damage and receive an "Adverse Opinion" of an audit result was potholes with mean value of 2.100 and 2,200 that is followed by Guardrail damage with mean value of 2,1667 and 2,200. While the least frequent damage in the toll road was Drainage cross section with mean value of 2.533 and 2,700 and Rutting with mean value of 2.400 and 2,633 subsequently for damage frequency and Adverse Opinion frequency.

1. Introduction

Toll road infrastructure is one of the most strategic transportation infrastructure facilities, therefore the condition of toll road infrastructure must continue to be properly maintained so that the level of road service is maintained. To maintain the condition of the toll road in good condition, a good and comprehensive road management and maintenance system is needed. Maintenance measures and capacity building for toll roads that are carried out regularly and continuously will maintain the quality of the road. However, the pavement that has been traversed by traffic will experience a decrease in quality, both structural and functional. Road maintenance is carried out continuously with good planning and sufficient funding, and selection of the right type of road maintenance is needed to overcome the decline in road quality.

On toll roads, road maintenance is necessary to provide comfort, smoothness and safety of traffic for toll road users. The 2013 toll road and Bina Marga Minimum Service Standards (SPM) have various types of maintenance handling for toll roads, which focus more on functional maintenance of toll road pavement. SPM for toll roads are indispensable to ensure the achievement of comfort, smoothness and safety of traffic for toll road users. in order to meet the SPM, Toll Road Company (BUJT) as the concession holder require to carry out adequate road maintenance to maintain pavement conditions that provides optimal service. Therefore, a method is needed to maximize the evaluation of road pavement conditions. In addition, related to the ineffectiveness of road

maintenance based on the age of the plan, the road authority requires an appropriate maintenance strategy due to budget constraints and time allocation [1]. Furthermore, the formulation of strategies as part of strategic planning is set to achieve the goals set according to the environment in which the organization operates and the productive activities of the organization [2]. Hence, the general rules of strategy formulation aim to utilize strengths, minimize weaknesses, take advantage of opportunities, and neutralize threats synthetically [3].

Moreover, at present, investment in toll road construction is conventional investment in the form of investment within a certain period of time to obtain profits from the results of capital loans / financing obtained from toll revenues during toll road operation during the concession period by the BUJT. This means that BUJT has full authority over the implementation of road maintenance at the location of its concession. Hence toll road concessions have the obligation to maintain toll roads in accordance with minimum service standards using the company's toll road revenues. As stated by Lu and Meng [4], under supplementary conditions, it was proved that the optimal toll revenue could fully cover the highway construction and maintenance cost in these contracts. Nevertheless, in many cases/ asset management principles are only being implemented ineffectively in maintaining highways [5]. Moreover, each BUJT has their own maintenance policy. Thus, the management of toll roads that are managed on a concession basis can lead to differences in road damage management programs in each BUJT concession. As a result, for these BOT highway contracts. Hence, this study is aimed to identify and analyze the road maintenance program planning on BUJT toll road concession holders to see the effectiveness BUJT in carrying out road maintenance that will have an influence on meeting service standards as well as the comfort and safety of drivers on Toll Roads.

2. Literature Review

2.1. Road Maintenance

The perseverance of the roadway is to carry on the road traffic safely and comfortably within the economic benefit capacity in term of both road user cost and road user agency, therefore several aspects have to be taken into consideration when designing and planning maintenance of a roadway. The examination can be analyzed and assessed based on the feature of road geometric, pavement condition and traffic volume with different treatment of project and maintenance. The purpose of road maintenance itself is to reduce the degree of road deterioration on a continuous basis. Different treatment that carried out will have different maintenance effect, therefore it will leads to different performance as over period of time. In addition, the treatment standard to which roads are maintained will affect the future performance of the road and also the total road cost. Consequently, it is essential to observe the variation in cost and overall road performance with different treatment maintenance standard to decide which treatment standard is economically optimal and appropriate [6]. It also suggest by [7] that road authorities should give higher priorities to preventive maintenance than corrective maintenance. In essence, by applying preventive maintenance, the road authorities can effectively decrease the need for future corrective maintenance while spending less overall. Hence it is clear that the selected maintenance program has a significant impact to road condition and therefore its influence on the fulfillment of SPM needs to be studied.

2.2. Minimum Service Standard

To guarantee the fulfillment of toll roads performance of and the services received by toll road user, the Government has set a service standard known as the Minimum Toll Road Service Standards (SPM). The existence of SPM is essential [8], SPM for toll road services are indispensable to ensure the achievement of comfort, and safety for road users. Also, from the perspective of accountability level, it can be analyzed that the Evaluation of Toll Road SPM fulfillment is the level of organizational accountability in the form of government accountability in this case the Ministry of PUPR through the Government Institution Performance Accountability Report which contains the performance achievements of the Ministry of PUPR, including the achievement of the performance of the operation of toll roads [9]

Table 1. Minimum Service Standards for Toll Road Conditions [10]

Indicator	Benchmark	Fulfillment Time
Skid	> 0.33 μm (for each lane)	-
Roughness	IRI ≤ 4 m / km (4 m / km for each lane)	-
Potholes	No Potholes 100%	2 x 24 hours
Rutting	No Rutting 100%	2 x 24 hours
Cracking	No Cracking 100%	2 x 24 hours
Guardrail damage	Functioning 100%	1 week
Drainage deposits	Functioning 100%	1 week
Drainage cross section	Functioning 100%	1 week

SPM for toll roads in Indonesia is referring to Regulation of the Ministry of Public Works No. 16 of 2014, regarding Toll Road Minimum Service Standards. In this Ministerial Regulation, the SPM has 8 service substances, specifically toll road conditions, average travel speed, accessibility, mobility, safety, rescue units, environment, resting places, and services as seen in table 1. Each service substance has indicators to be measured and it must be met by BUJT as a concession holder. The substance for toll road conditions are as follows:

1. Pavement indicators are of skid, roughness, exempt from potholes, rutting, and cracking. The fulfillment of indicators must be carried out within 2x24 hours.
2. The indicator for road shoulder exempt from potholes, rutting, cracking, and rounding. This indicator covers all toll roads. The fulfillment of indicators must be carried out within 2x24 hours.
3. The indicator on drainage are exempt from deposits and channel cross section is functioning optimally. The fulfillment of indicators must be carried out within 1 week.
4. The indicator for median is exempt from damage on curbs, median concrete barriers (concrete lane separators), guard rails (retaining iron that functions as a fence). The fulfillment of indicators must be carried out within 1 week.

Since maintenance is the responsibility of the toll road business entity, consequently BUJT that operates the toll road is obliged to meet SPM. Otherwise the road user is able to file compensation or dispute resolution either directly, through litigation or non-litigation to the BUJT [11]. The study of SPM fulfillment has been carried out in the previous year. SPM implementation in Semarang toll road was studied [12]. Makmur and Rajagukguk [8] assessed the indicators which cannot always be met in the toll road sections that have been operating in Indonesia, however it only studied SPM fulfillment indicator of road pothole. There are no studies on the maintenance program carried out by BUJT towards the fulfillment of SPM. Therefore, the correlation between road maintenance and SPM need to be reviewed.

3. Method

In this study the method of data collection is done by taking secondary data and primary data. Primary data obtained by distributing questionnaires that are closed to the respondents as research subjects. A number of 40 questionnaires were distributed to BUJT staff that hold responsibility related to Road maintenance. However, 5 questionnaires cannot be used because the respondent's main task is not related to road maintenance. Therefore, a total of 35 questionnaires were taken as an input in this research. 10 BUJT which manage the toll road in Indonesia becomes a case study place. The study begins by identifying factors related to road maintenance through interviews with experts in highway maintenance.

Data collected covers the current road conditions and the maintenance program. The questionnaire distributed contained questions about the conformity of the implementation of road maintenance in each BUJT with reference to technical guidelines for toll road maintenance in accordance with The Regulation of The Ministry of Public Work number 02/PRT/M/2007 which consisting of road maintenance items, road maintenance management, road maintenance surveys, and road maintenance inventory systems. In addition, the questionnaire also contains survey regarding the

frequency of toll road damage, audit results conduct by BPJT and the achievement of SPM fulfillment. The data was then analyzed to find out the toll road maintenance strategy in each BUJT and its influence on the service standards achieved.

4. Discussion

From a total of 35 respondent from BUJT in Indonesia, 5 respondents must be excluded as the respondent field of work is not related to road maintenance. Respondents who were considered in this survey consist divided into several groups of work experience related to road maintenance. as much as 74.3% has been working up to 5 years, 17,1% have 6 – 10 years of experience, 2,9% have 11 – 15 years of experience, and 5,7% has been working for more than 15 years in the road maintenance field. From the mean analysis it was found that not all maintenance items required by the standard have been performed by the BUJT.

Table 2. Items from the maintenance item questionnaire in descending order of mean score

Item Number	Item Statistics	Mean	Std. Deviation	N
3	Undertake routine efforts throughout the year to maintain road conditions.	3.5000	0.51	30
2	Cut of grass, pruning trees and controlling water in the space owned by the road and the road supervision room	3.4667	0.51	30
4	Patch pavement and shoulder, or make minor repairs of other elements of the structural functioning road	3.4333	0.50	30
1	Cleaning / repairing minor drainage systems	3.3667	0.49	30
6	Ensure drainage system on all roads has adequate capacity.	3.3333	0.55	30
7	Ensure elements of the road on all roads are in good condition.	3.3333	0.55	30
10	Perform minor repairs of pavement and shoulder surface shapes, including surface patching	3.3333	0.55	30
14	Assess roughness using NAASRA-meters or other devices that have the same function	3.3333	0.48	30
12	Ensure pavement surface and road shoulder have adequate transverse shape	3.3000	0.47	30
15	Examine the shape of the pavement and shoulder surfaces in the transverse direction using ruler, or visual assessment	3.3000	0.47	30
9	Assessment is assisted with measurements using simple tools	3.2667	0.45	30
11	Ensure pavement on all roads has a minimum roughness of 0.33 and a maximum unevenness of 4 m / km IRI	3.2667	0.45	30
13	Assess skid surface with a Mu-meter or other device that has the same function	3.2667	0.52	30
5	Ensure pavement and shoulders on all roads 100 percent perforated and free from other damage	3.2000	0.55	30
8	Perform visual assessment on foot	3.0333	0.61	30

It can be seen from table 2, the rankings (by mean) for maintenance practice item taken from The Ministry of Public Work technical guidelines for toll road maintenance. From the questionnaire result the three highest mean was for the item “Undertake routine efforts throughout the year to maintain road conditions”, “Patch pavement and shoulder, or make minor repairs of other elements of the structural functioning road“ and followed by “Cut of grass, pruning trees and controlling water in the space owned by the road and the road supervision room”. Meanwhile, the three items with the lowest mean, were “Perform visual assessment on foot”, “Ensure pavement and shoulders on all roads 100

percent perforated and free from other damage", and "Assess skid surface with a Mu-meter or other device that has the same function". This result shows that the majority of BUJT has regularly carried out efforts to improve road functions, however they have the inadequacy in conduct conditions surveys by using equipment according to the standards. Whereas road condition monitoring and assessment should be a primary key for road maintenance activities to evaluate pavement performance and moreover to predict road deterioration behavior throughout its service life.

The accuracy of road deterioration models depends on the type of algorithms, number of effective variables, number of measured data and accuracy of the instruments and measurements [13]. Also, identify the vulnerabilities affecting roads infrastructures is essential to attribute a risk level and consequently to plan a priority order of maintenance interventions [14]. Subsequently, the survey conducted to collect data must also be appropriate since information on several pavement condition characteristics is critical to performing management functions. The characteristics include roughness, skid resistance, structural capacity, and distress. Thus, to determine the type of road maintenance needed, the road agency have to carry out the process of evaluating the road conditions, to ensure that the type of proposed maintenance will be truly appropriate.

Taking into a closer look to this occurrence, it is showed in the table 3 that PCI test has the lowest value of mean with only 2,867 when compared with IRI test and SKID test with 3,2 and 3,1 mean value. Whereas substantively PCI is the most widely used ratting to measure pavement performance. This means, again that the BUJT does not conduct a comprehensive assessment of road conditions and only assesses individual type of road damage.

Table 3. The use of road condition evaluation survey tools

Item Statistics	Mean	Std. Deviation	N
IRI	3,200	0,48	30
SKID	3,100	0,48	30
PCI	2,867	0,68	30
Sondir	2,967	0,76	30
Boring	2,900	0,80	30

Pavement management system typically employs a PCI as the basis for evaluation of current and future pavement condition. PCI indicates the present condition of pavement in terms of structural integrity and surface operational condition [15]. The PCI provides an indication of the current performance of a pavement using pavement distress data, which includes different distress types, severity levels, and densities, and takes the form of a numerical rating, between 0 and 100 that is used to indicate the general condition of a pavement. With all the fittings, the PCI method is recognized as one of the most comprehensive methods of estimating the functional conditions of roads [16]. Therefore, PCI supposed to be used as an indicator of toll road performance and its implementation in Indonesian toll road is significant to optimize road maintenance planning and to minimize road damage.

Table 4. Frequency of Road Damage and SPM Audits

Item Number	Item Statistics	Damage Frequency		Audit Adverse Opinion		N
		Mean	Std. Deviation	Mean	Std. Deviation	
1	Potholes	2.1000	0.66	2.2000	0.55	30
2	Rutting	2.4000	0.62	2.5333	0.57	30
3	Cracking	2.2333	0.63	2.3000	0.53	30
4	Guardrail damage	2.1667	0.59	2.2000	0.66	30

5	Drainage deposits	2.2333	0.68	2.6333	0.56	30
6	Drainage cross section	2.5333	0.63	2.7000	0.60	30

Furthermore, regarding for highway damage conditions, it is reported that with current maintenance program carried out, the most frequent damage was potholes with mean value of 2.100 that is followed by Guardrail damage and Cracking with mean value of 2,1667 and 2,233 subsequently. On the other hand, the least frequent damage in the toll road was Drainage cross section with mean value of 2.533 and Rutting with mean value of 2.400. Accordingly, the road damage frequency data is also conforming with the audit findings result that is conducted by BPJT.

Based on PUPR Minister Regulation No. 6 of 2018 regarding the Authority and Duties of Directorate General of Highways (DGH), BPJT, and BUJT in the Operation of Toll Roads, it is regulated that the evaluation of SPM fulfillment is conducted by DGH, BPJT and BUJT. DGH is responsible for conducting technical evaluation. BPJT is responsible for conducting operational evaluations, while BUJT is responsible for meeting SPM requirements. The audit of SPM fulfillment carried is out by BPJT every 6 months in accordance with what is stipulated in the Toll Road Concession Agreement (PPJT). While for each month, an SPM compliance evaluation is conducted by the BPJT Team. However, aside from having the highest frequency of occurrence, road pothole is the most frequent damage to get the form of "Adverse Opinion" of an audit result. And on the contrary, Drainage cross section is the least damage to get the "Adverse Opinion" from BPJT.

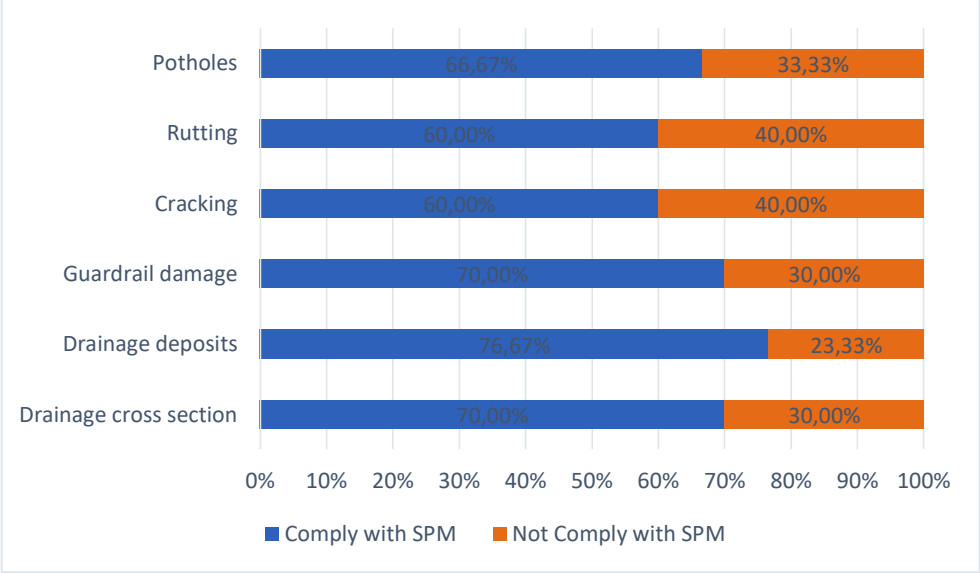

Figure 1. SPM fulfillment time Compliance

Consequently, after getting the audit results the results of an audit in the form of Adverse Opinion, BUJT is require to immediately repair the damage found by BPJT with a specified maximum corrective time as stated in the SPM. However, the time limit specified in the standard are often cannot be fulfilled by the BUJT as seen in figure 1. As much as 40% of rutting and cracking repair time cannot comply with the SPM. In addition, about 30% of potholes, guardrail damage, and drainage cross section repair time are also cannot comply with the SPM. Whereas for drainage deposit cleaning, there are only 23.33% of the mentioned work that cannot meet the SPM repair time standards.

Subsequently by considering at the implementation of road maintenance carried out by BUJT from the survey results of maintenance activities and SPM monitoring, it can be determined that road damage occurs in associated with the operational and maintenance management carried out by the operator. Therefore, BUJT as the toll road administrator needs to carry out a road condition assessment survey regularly to program the most effective maintenance program in order to prevent

road defect that will result in received an Adverse Opinion audit result from BPJT. In addition, by implementing an appropriate road maintenance program, the Adverse Opinion audit findings will be decrease. Thus, if the BUJT nevertheless required to repair road damage that is found by BPJT, they can enforce to comply with the SPM repair timespan as the number of defects is minimized.

5. Conclusion

From the findings it was found that not all maintenance items required by the standard have been performed by the BUJT. From the mean analysis, it can be distinguishing the maintenance items that are routinely performed and vice versa. The result shows that the majority of BUJT has regularly carried out efforts to improve road functions, however they have the inadequacy in conduct conditions surveys by using equipment according to the standards. with "Undertake routine efforts throughout the year to maintain road conditions" being the highest mean whereas "Perform visual assessment on foot" has the lowest mean value. This research shows that PCI test has the lowest value of mean with only 2,867 when compared with IRI test and SKID test with 3,2 and 3,1 mean value. To this occurrence it means that the BUJT does not conduct a comprehensive assessment of road conditions and only assesses individual type of road damage. Whereas PCI is the most comprehensive methods of estimating the functional conditions of roads. Therefore, PCI supposed to be used as an indicator of toll road performance and its implementation in Indonesian toll road is significant to optimize road maintenance planning and to minimize road damage.

In addition, it is reported that the most frequent damage was potholes with mean value of 2.100 that is followed by Guardrail damage and Cracking with mean value of 2,1667 and 2,233 subsequently. On the other hand, the least frequent damage in the toll road was Drainage cross section with mean value of 2.533 and Rutting with mean value of 2.400. Accordingly, the road damage frequency data is also conforming with the an "Adverse Opinion" audit findings result that is conducted by BPJT. In the manner of the study results it can be determined that road damage occurs in associated with the operational and maintenance management carried out by the operator, and therefore BUJT as the toll road administrator needs to carry out a road condition assessment survey regularly to program the most effective maintenance program in order to prevent road defect that will result in received an Adverse Opinion audit result from BPJT

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