The Implementation of Road Evaluation and Monitoring System at The City Road Conditions

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Abstract. The rapid development of new city road infrastructure causes the ignorance of Indonesian people to think about maintaining road infrastructure that has been built. This is indicated by the weak effort in maintaining road infrastructure by the agency, for example: the absence of a good historical record of a road section when it was started to be built until it is maintained, there is no continuity and integration in recording the history of road segments. It is needed an action to solve problems by forming a road maintenance management system. This research involves two types of primary data consisting of system framework data and case study data. The first serves as a determinant of the direction of computer programming logic that can function as a blueprint for the process of storing, processing and presenting case study data, while case study data is factual field data obtained by conducting a direct survey on four city streets, namely, Joko Tingkir street, Monginsidi street, Ir. Juanda and Kyai Mojo street. All damage images, type and segment coordinates of the field are recorded using the Road maintenance and Monitoring System application (REMS). The Pavement Condition Index (PCI) value of each road section are displayed and generated by the Android REMS application will be then processed to determine the maintenance and rehabilitation great strategy.

1. Introduction
At the preparation of a road maintenance management system, data inventory is needed, the data required must contain at least damage conditions, class, geometry and location of the road. The data contained in this inventory are important variables and parameters that can be collected, compiled and processed in a database system that functions as an input form, data processing and presentation, along with recommendations in providing maintenance implementation options as one of the supporting tools for decision makers.

1.1. Pavement condition index
The PCI method is a method developed by the United States Army, this method uses statistical measurements and requires visual observation. The measurement results of this method are index numbers from 0 to 100 which indicate the damage conditions of a road section. This method is a process of evaluating the procedures contained in ASTM D 5340 rules, used throughout the world by considering the functional parameters of the road that have a significant influence on the strength of the road structure [1]. Basically, in evaluating the performance of road conditions can be seen into 2
(two) points of view, namely, functional performance and structural performance. Functional performance is more directed at driving comfort, assessment based on methods and structural performance is more directed at the structure of the road section. Ideally, an assessment by looking at functional performance and structural performance must be carried out to guarantee the longevity of pavement service life, but in Indonesia it is only assessed by looking at functional performance, even though it is carried out by various methods of assessment simultaneously [2].

1.2. The type of pavement deterioration
A road infrastructure that is completed, with increasing time will experience a decrease in quality. Determination of the average PCI value can only be obtained after identification of damage to each observed road segment, according to Shahin (2005) [3], the following are the types of road damage:
1. Alligator Cracking, Fine cracks, longitudinal hair cracks run parallel to each other with fissures that connect each other.
2. Bleeding, Asphalt overweight is seen on the surface of the wear layer, asphalt can be sticky on the vehicle's wheels or shoes.
3. Block Cracking, Cracks form square blocks and are interconnected.
4. Bumps & Sags. The pavement is a pavement which affects the quality of driving.
5. Corrugation, Crimped asphalt which affects the quality of driving.
6. Depression, Localized hardness areas experience a slight decrease in elevation.
7. Edge Cracking, Pavement cracks on the edge of the road due to an old asphalt binder mixture.
8. Joint Reflection Cracking, Crack on areas where there is no filler or cracks on areas filled with fillers on the joint.
9. Lane / Shoulder Drop Off, There is a high difference between the edge of the pavement and the shoulder of the road.
10. Longitudinal & Transverse Cracking, Crack on areas where there is no filler or cracks on areas filled with filler.
11. Patching and Utility Cut Patching, On the road, patches with reduced quality and comfort in the road are disturbed.
12. Polished Aggregate, Aggregate already looks smooth and worn.
13. Potholes, A hole occurred in the road section.
14. Railroad Crossing. There are railroad crossings that cause a decrease in driving comfort.
15. Rutting, Decreased pavement surface that occurs in the vehicle's wheel grooves.
16. Shoving, Urgent asphalt causes a decrease in driving comfort.
17. Slippage Cracking, Cracks occur that cause deformation.
18. Swell, Asphalt expands / bumps causing a slight decrease in driving comfort.
19. Weathering and Raveling, The aggregate or asphalt binder starts to detach. diameter.

1.3. Road Evaluation and maintenance system
REMS is an acronym for Road Evaluation and Monitoring System, an android application system that is useful to simplify the calculation of PCI values of roads without having to do graphical calculations on PCI nomograms. This application is also equipped with a photo damage documentation feature and location recording. This study uses the help of the REMS application to make it easier for authors to calculate PCI values in each section of the road. According to Setyawan (2017) [4], REMS applications involve various types of sensors and programs that can help detect road damage and simultaneously record data in the form of geographic information systems [5,6].

2. Experimental
Research conducted is descriptive quantitative based on primary data obtained directly from the field (based on factual conditions) and secondary data obtained from interviews from relevant sources. Primary data and secondary data will be combined and processed to complement each other. Data that has been processed are expected to produce a conclusion from the comparison of the data conducted.
The places used in this study are 4 urban road sections under the auspices of the Public Works and Public Housing Agency of the Surakarta City Government. Basic data collection uses the scope of the project level and has the heaviest axle load (MST) of 8 tons, the category of strategic roads, the type of flexible pavement that supports economic activities, offices, tourism and education and is traversed by freight transportation. Following are the 5 roads that were observed:

1. Joko Tingkir Street (Length: 950m; Width: 7m)
2. Ir. Juanda Street (Length: 3,200m; Width: 10m)
3. Monginsidi Street (Length: 1820m; Width: 9.5m)
4. Kyai Mojo Street (Length: 1320m; Width: 7m)

This research involves two types of primary data consisting of system framework data and case study data. System framework data serves as a determinant of the direction of computer programming logic that can function as a blueprint for the process of storing, processing and presenting case study data, while case study data is factual field data obtained by conducting a direct survey on four city streets, namely, Joko Tingkir street, Monginsidi Street, Ir. Juanda and Kyai Mojo street. The system framework data is in the form of a basic algorithm in the form of a logic logic blueprint regarding:

1. Data of observed road segment objects.
2. Segment coordinate data for each road segment.
3. Road damage data.
4. PCI value data.

3. Results and discussions
This study uses the results of recording geographic data in the form of coordinates obtained from the reading of the Global Positioning System (GPS) on a smartphone. The use of geographic information systems is very helpful in the delivery of integrated information as conveyed by Pantha (2010) [5] which states that geographic information systems can be used to manage and describe various types of data in an integrated or separate manner which in turn can help the decision making process in planning road maintenance. One element in the geographic information system is the coordinate system, in this study the coordinates recorded are the coordinates of the damage points on the road, the coordinates of the stationing point of the road every 100 meters to divide the road segments into segments. The results of the recording of this road damage point will be linked to the station stationary segment and will eventually be displayed in a web page display along with other road segments observed. The results of this merger can facilitate the user in analyzing and identifying patterns of damage applied. The reults of using Road Evaluation and Monitoring system are presented in Project Module, Stationing Module, PCI module and Recapitulation Module.

3.1. Project level module
The module shown in Figure 1 presents four observed roads, namely Joko Tingkir Street, Monginsidi Street, Ir. Juanda and Kyai Mojo street. Each observed road section is given additional information in the form of naming the project or work package, type of maintenance, dimension data of the road section, classification data and administrative location of the road section.
3.2. The stationing module
The Stationing Module is presented in an interactive digital map format that can be clicked on each station to find out the station's STA information, in addition a table containing station details and coordinates are presented. The module in Figure 2 shows that the Joko Tingkir road section has 19 stations and 18 segments. The other road segments are presented at the similar pattern.

3.3. The road deterioration module
With this module, users can identify images, the amount and type of damage that occurs on each road segment that has been classified by segment. Modules are presented in the form of interactive digital maps, tables and pie charts. Figure 3 shows that, Joko Tingkir road suffered 10 types of damage. The most common types of damage are patching and utility cut patching and polished aggregate types.

Figure 1. The Project level module.

Figure 2. The typical of stationing module at Joko Tingkir street.

Figure 3. The road deterioration module.
3.4. The pavement condition index module

With this module, the pavement condition index value can be observed in detail by clicking on the graph nodes. In addition to the graph also provided a table containing the segment along with the PCI value of the segment. Figure 4 shows that the Joko Tingkir road has a total PCI index of 89.16.

3.5. Recapitulation module

In Table 1 shows the recapitulation of maintenance costs on the observed roads. In the damage survey that has been carried out, the most amount of damage is on the Ir. Juanda street, this is because the length of the track is also the longest with a PCI value of 79.60.

| Road Segment | Length (km) | Width (m) | The number of deterioration | PCI Value |
|--------------|-------------|-----------|-----------------------------|-----------|
| Joko Tingkir | 0.95        | 7         | 42                          | 89.16     |
| Monginsidi   | 1.82        | 9.5       | 54                          | 89.54     |
| Ir. Juanda   | 3.2         | 10        | 102                         | 79.6      |
| Kyai Mojo    | 1.32        | 7         | 93                          | 52.4      |

In this study also analyze that the value of PCI can not directly affect the amount of maintenance costs or can be said there is no relationship, the underlying thing is not a strong connection between
the value of PCI and maintenance costs is, the calculation of maintenance costs is very dependent on the area or volume of damage and also influenced by the maintenance method and the standard price of the selected work unit. The choice of maintenance method and standard unit price of work are additional factors that can obscure the value of PCI as a representation of pavement conditions if brought into the context of calculating maintenance costs [7]. From these findings, it can be shown that road section documentation to be used as a database as a tool for road management and maintenance is very useful in conducting deeper analysis of existing variables. With the ongoing survey and input of new roads, in the end it can sharpen the user analysis in processing the available road segment database.

4. Conclusion
From the results of the discussion in this study, we obtained several important conclusions, namely documenting any road pavement conditions regularly or planned is highly recommended because this is an easy and inexpensive step for stakeholders in order to establish a good road maintenance database that can ultimately help in the process of analysis and planning for maximum maintenance. Road maintenance database system that is maintained in quality as well as by presenting data in an orderly and integrative manner can guarantee reservation of road pavement conditions in accordance with expected levels and enable the achievement of sustainable road infrastructure management and ultimately can have a large cost-saving impact and can provide services to society in prime.

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