THE IDENTIFICATION OF ROAD CONDITION USING SMARTPHONE ROADROID APPLICATION BASED ON CORRELATION METHOD (CASE STUDY: BYPASS LOMBOK INTERNATIONAL AIRPORT)

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ABSTRACT

A road is a land transportation infrastructure that plays an important role in regional development. Road feasibility assesses through road roughness. The purpose of this study is to assess the condition of road roughness based on the ASTM E 950-94. The technology used is a correlation-method-based Smartphone application called Roadroid. There were several types of data obtained, namely spatial data in the form of maps, visual data in the form of photos and videos, and numerical data in the form of IRI (International Roughness Index) values. Based on numerical data analysis, the indicated IRI values ranged from 2,01 to 2,13. These results represented that the Lombok International Airport Bypass road condition is currently in good and moderate condition.

Keyword: *IRI, Road Condition Asessment, Roadroid*

1. INTRODUCTION

A road is a land transportation infrastructure that plays an important role in supporting a transportation system linking one place to another, besides, it improves economy, increases social development, and supports regional development. The feasibility of road conditions can be assessed through the roughness of the road surface.

The value of this road condition can later be used as a reference to determine the type of evaluation program that must be carried out in the future, whether it is an improvement program; periodic maintenance; or routine maintenance.

The right road maintenance selection is carried out by assessing the road surface condition using several approach methods, namely, the IRI method and the Visual method, in this case, the Surface Distress Index (SDI) and Pavement Condition Index (PCI) method. The method has its own advantages and disadvantages. The disadvantages of the IRI method are it requires a large cost and complicated tool operation, while the disadvantages of the visual method are it is less effective and subjective.

Therefore, along with the technology development, people discover a more effective and efficient tool using the IRI approach method, namely a Smartphone application called Roadroid. Roadroid is a correlation-based smartphone application invented by Lars Forslof, this application has gone through several adjustments and improvements since its discovery in 2003 which at that time could only be used on computer devices (PCs) only in 2010 this application was improved and simplified in such a way that can be used on Smartphones.

This application works by utilizing the accelerometer feature on the Smartphone

which will record the unevenness of the road which has been calibrated with some adjustment [1]. Thanks to the application of Roadroid, the measurement of road condition values can be carried out effectively and efficiently, to facilitate the government in preparing optimal road handling programs.

2. LITERATURE REVIEW

To determine road serviceability a characteristics-based data is needed. The roughness measuring equipment is classified by the ASTM E 950-94 standard, which is divided into four groups based on the accuracy level and the method used in determining the IRI[2][3].

A. Class I
   This class uses the highest accuracy standard equipment. The profiles are measured as a series of points with a fairly tight level of precision.
B. Class II
   This class considers dynamic measurements that define elevation profiles either with elevation data or by combining statistical calculations from elevation data.
C. Class III
   Measurements made using this method require calibration between Class I and Class II equipment using standard pavement values.
D. Class IV
   Subjective assessment conducted by doing a visual assessment. Between surveyors must have the same standards so that the results obtained are consistent between surveyors.
   Based on Table 1, it can be seen that each class has its own equipment, with its respective functions and characteristics.

Table 1. The equipments example on method class

Level	Method	Equipment
Class1	*Lassser Sxanner* Technology	*Hawk eye*
Class 2	*Complex Profilometer*	APL *Profilometer*, NAASRA *Profilographs Optical Profile*
Class 3	Corelation Method	*Roadroid, Roadmaster*, ROMDAS, *Roughometer*, TRL Bump *Integrator*

Source : *Data Collection Technologies, Worldbank*

Based on Table 2, it showed the advantages and disadvantages of each survey method from each class.

Table 2. The advantages and disadvantages of each survey method

Method	Advantages	Disadvantages
Laser scanner Technology (*Class* I) Hawk Eye	Very high precision, able to determine cracks or road damage, know road geometry and assets, available in image or video capture format, integrated with GIS applications	High operating costs, can't operate when it's raining, can't operate on narrow roads.
Profilometer kompleks (*Class* II) NASSRA	Medium precision, adjustable reading interval, integrated with GPS, large data capacity	Requires equipment calibration, relatively expensive, requires equipment installation on vehicles, not yet integrated with GIS applications, long survey times, no video capture available
Metode korelasi (*Class* III) *Roadroid*	Reasonably priced, 80% laser method precision, portable, can be used on unpaved roads, low maintenance cost, surveillance capacity 100 km/day, can be used on narrow roads, integrated with GIS, photo or video capture available, reading interval can be set	Needs to be calibrated, sensitive to vehicle and GPS influences.
Visual Method (*Class* IV) SDI	Easy conducted, unpricey	Accuracy depend on subjective between surveyor, need conversion to IRI

Source : variuos sources

Based on this matter, the use of Roadroid (Class III method) could be the optimal choice with an advantage in terms of

relatively cheap, produce accurate data, easy to operate, and require a relatively short[2][3]

Roadroid is a smartphone-based program to assess road roughness (IRI) using a smartphone accelerometer that able to store road conditions photos and videos automatically. This program developed in Sweden by Lars Forsflof and won the IRF Global Road 2014 in Technology [4], Equipment, and Manufacturing. The data obtained from this method include spatial data in the form of maps, visual data in the form of photos or videos, and numerical data in the form of IRI values.

3. METHODOLOGY

The stages in this *Roadroid* research are shown in **Figure 1** starting from the preparation stage to results processing. **Figure 2** shows the *Roadroid* application stages.

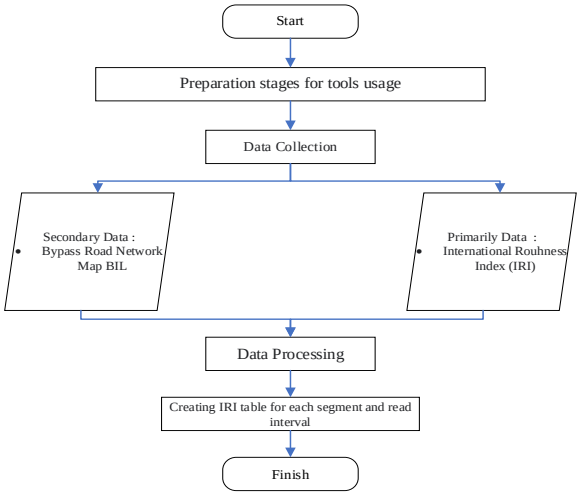

Figure 1. Research Flowchart

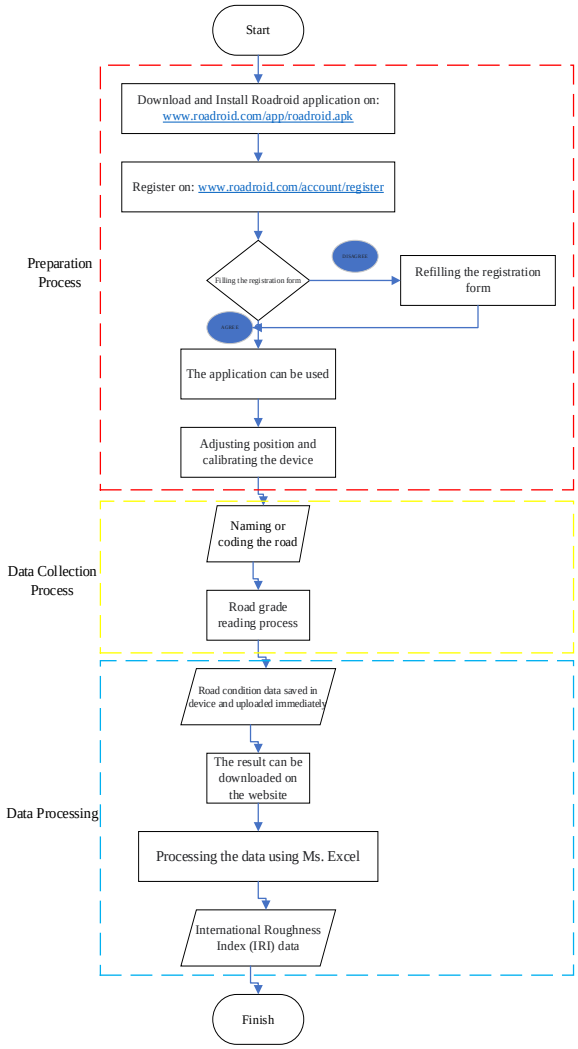

Figure 2. *Roadroid* Flowchart

3.1 Roadroid

3.1.1 Preparation

Before conducting a survey using the roadroid method, some preparations are conducted as follows:

1. Device
   The main preparation to do this method is providing an Android smartphone with equivalent specifications or higher than the Samsung Galaxy S5 type and the operating system version used 4.4. or 5.0 batch[4]. The roadroid app is downloaded at www.roadroid.com/app/roadroid.apk. Each device only gets one username and password to access the website based on the IMEI number of each device.
2. Device position and calibration
   The device is placed on the car dashboard using a car-holder.

Figure 3. *Roadroid* position for survey

The device position must be ensured in a stable position. Then adjust the calibration to adjust the position between the device and the X, Y, and Z axes. After the roadroid application opens, click fitting adjustment, on the screen and you will see X, Y, and Z. Adjust the position of the device so that the X, Y, and Z values become 0 or until the grass marks turn green.

Figure 4. *Roadroid* calibration procedure

3. Vehicle
   The vehicle must be in a good performance because the vehicle's performance will greatly affect the generated IRI data accuracy. Minimal shaking will make the IRI data legible precisely.

3.1.2 Data Collection

During road data collection , several stages must be considered, includes:

1. Data collection starts from the end of the segment base by clicking (start and stop sampling).

Figure 5. Start sampling

2. Road is given easy codes names and integrated with another road.

Figure 6. Naming the road survey

3. Let the Roadroid application to work during the survey from the start point to the endpoint of the road.

Figure 7. Survey Reading Process

4. At the end of the road, data collection is stopped by clicking (start and stop) again.

Figure 8. Stop sampling

5. Road condition and documentation data are stored in the device, data collection can be restarted. And it goes on.
6. The stored data must be immediately uploaded to the internet so that it is properly archived in the Roadroid website internet database.

Figure 9. *Roadroid* Website

4. RESULT AND DISCUSSION

The uploaded survey data will be stored on the internet and able to be read in roadroid website address by logging in using the username and password that you obtained previously. The data includes:

1. Road condition network map
2. Database of specified interval roads (20m, 50m, 100m, etc.)
3. Photos or Videos of road conditions used to validate conditions or IRIs.

4.1 Road Condition Network Map

Road condition network maps from the Roadroid results can be downloaded on the website. This data can be automatically displayed in Google Maps application or GIS by processing the numerical data with QGIS or ArcGIS software formerly.

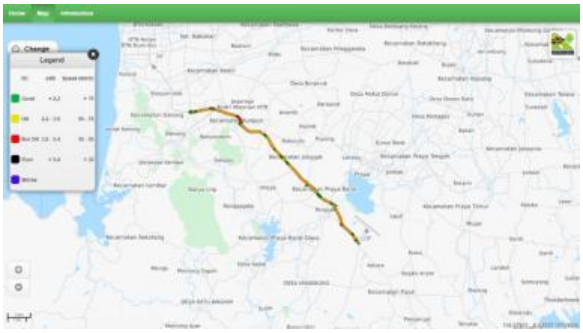

Figure 10. R*oadroid* survey result map on the *website*

4.2 IRI Survey Result Data

Based on a survey on 20,8 Km Bypass road - Lombok International Airport, it is known that the average IRI value is as follows, the East-West track for the left lane is 2,13 and for the West-East track the left lane is 2,01. The road condition was shown by the following graph.

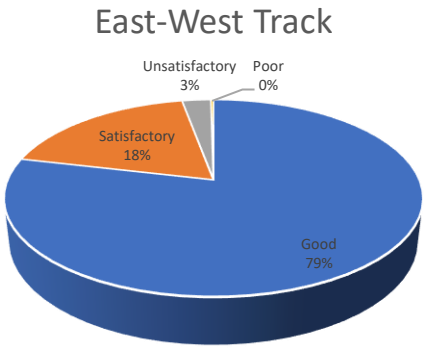

Figure 11. The East-West Track road condition graph

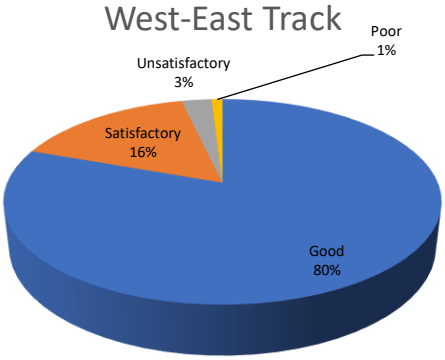

Figure 12. The West-East Track road condition graph

Based on Figures 11 and 12, the east-west road condition and the opposite direction is shown in a good (good) road condition by

79%, moderate (satisfactory) road by 18%, lightly damaged 3%, and heavily damaged 0%. The opposite direction is 80% good road, 16% satisfactory road, 3% lightly damaged road and 1% heavily damaged road.

4.3 Road Condition Photos

To validate the results with Roadroid numerical data (IRI), it is compared with the actual condition of the road. Photos of the road conditions were taken throughout the survey.

Figure 13. Heavily damaged road (Poor)

Figure 14. Lightly damaged road (Unsatisfactory)

Figure 15. Moderate road (Satisfactory)

Figure 16. Good road (Good)

5. CONCLUSION

Roadroid is a value measuring road conditions tool based on the correlation method which is more effective and efficient compared to other tools. Based on the survey on 20,8 Km Bypass road - Lombok International Airport, the average IRI value is as follows, the East-West line for the left lane is 2,13, for the West-East direction the left lane is 2,01. In addition to data in the form of IRI values, the results obtained through this tool are in the form of road conditions network maps and photos or videos of road conditions.

The writer concluded that the Roadroid technology makes it easier for the government to develop optimal and efficient road handling programs also it can be a reference for academics who assess road conditions to use the Roadroid application which was proven to be effective and efficient in measuring the value of road conditions, this is evidenced by the application of roadroid on road database updating activities in the District South Lampung, successful data obtained inventoried with the total roads surveyed reaching 1.250 km with a survey time of approx. 2 weeks and costs less than 25 million rupiah[5].

In addition, it is also supported by the results of research in 2018 showing that the survey results from the NAASRA roughmeter II tool and the roadroid smartphone application did not have a significant difference[6].

6. RECOMMENDATION

The suggestions that can be given from this research are:

1. Further research needs to be done by paying more attention to variables such as speed (constant), tire type and

pressure, and vehicle condition (minimum 5 years usage)

2. Comparing the results using Roadroid with another methods and tools.

7. REFERENCES

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