Mobile-Based Application for Versine Improvement by Using Flutter Framework

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Abstract. A mobile application for recording and calculating the ideal versine for the railroad curves maintenance program in the field is needed to help reduce time and effort in calculating. This study intended to create a smartphone-based application for railway curves versine and cant calculation to improve railway curve monitoring and maintenance. The application was designed with flutter framework and dart programming language which can be installed in android-based smartphones so that the maintenance officer can calculate the versine at site by using smartphones. Comparative analysis with Ms. Excel calculation was conducted to check the application function. The case for this study was curves data from KM 24+014 to 24+091 between Sepanjang Station-Boharan Station in Surabaya with a 5000 m radius. Based on the case study, the data result of Microsoft Excel and the application showed the same results for calculation tables that consist of effect (+), effect (−), total realignment, new versine, and same of graphical illustrations. After comparing between using Microsoft Excel and the application, it can be suggested that the application can be used for curves monitoring and calculation for maintenance, it also worked well without internet access.

Keywords: Railway Curves · Curves Maintenance · Versine · Realignment · Mobile Application

1 Introduction

After the operation of the railway system, rail track degradation began, and maintenance was needed to maintain train safety and passenger comfort [1]. One of the critical aspects of railway track operation was how to keep the curve geometry as the requirement. Curves maintenance was essential to improve the smoothness of the train movement and increase the speed and level of travel comfort [2]. The work of realigning and transitioning curves is started by surveying the existing curve by measurement of versines, determination of the revised alignment, and computation of slews which include the provision of correct Super-elevation and slewing of the track to the proper alignment [3].

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Before the maintenance was conducted, the curve condition was measured. As In Indonesia, the curve inspection should be scheduled every six months [4]. During the operation, the centrifugal force from the train resulted in a shift of the versine on the horizontal alignment and decreased the railway road level [5].

The indicator of the curve radius regularity can be determined by measuring the versine using a chord 20 m long, and the measurement was conducted at 10 m interval. After the inspection, the curve and versine data will be recorded. The calculation to maintain the curve to the ideal condition with the proposed value of the versine was usually done in the office using Microsoft Excel.

A mobile application that provides support for recording and calculating the proposed versine in the field is needed to help reduce time and effort in calculating the ideal versine for the maintenance program. Therefore, the study tried to create a mobile application for the versine inspection and maintenance program using the flutter framework.

2 Method

Versine is the perpendicular distance measured at the midpoint of a chord from the arc of a curved track [3]. Versine measurement aimed to find the versine data for each stated interval. The activity needs tools such as a track meter gauge, ruler, and versine measuring equipment [6]. Versine inspection is taken along the gauge face of the outer rail, and a mark with paint can be made on the gauge face of the outer rail at three stations behind the beginning and end of the curves. A fishing cord or wire was stretched out over the entire cord length, and the versines were measured in the middle of the string with mm accuracy at each station from one end of the curve. Figure 1 illustrates how the versine was measured with a 20 m chord on a railway curve.

Versine's measurement data is used as a reference for making a chart to inspect the condition of versine and curve. And then, a calculation is made to repair the versine to its ideal state. Realigning of the track must be counted correctly before undertaking the maintenance work.

This study created a mobile application that runs from a smartphone or mobile device. Furthermore, the application is made for android, which provides open software for developers to make their applications. The application was created using the flutter framework with a *dart* programming language in a Microsoft Visual Studio text editor. Application development starts from database design and continues with application feature design. Features of curves calculator application consist of curves list, curves

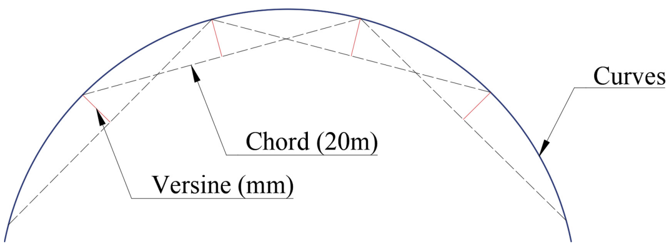

Fig. 1. Illustration of Versine measurements

data, data input, data calculation, graph, and table simulation. In the next step, the formula for curve calculation was converted to dart programming language, with export data feature to store calculation data in Microsoft Excel format. After the application was finished, the test was conducted with the BlackBox method, which focused on its functionality to ensure the application ran according to the design with two curves inspection data.

3 Results

3.1 Aplication Design

The application was built using a flutter framework with a dart programming language that can run in android operation systems. But this mobile app can't be used on iOS because the developer used the windows operating system to build the app, while iOS needs iOS SDK that can be found on macOS. SQLite was a local application database that could run without an internet connection. It is also easy to manage, stable, expanded, fast and flexible, operated in a mobile device, and simple, so it can avoid overhead [7]. The text editor for this mobile app is Microsoft Visual Studio Code.

The steps to build the application includes: design of the application database, design application feature, design application data list, design of input data curves, calculation of curves data, design table feature and graphics, design of export data to Ms Excel feature, the results can be shown on Fig. 2.

Figure 2 shows the application interface, information about the application, manual users, and a list of curves at the top of the menu. The content of curves versine data is based on data for each measured point by using curves list and curves nameplate as a reference document. Versine data consists of point number, versines measurement value, versine realignment value, and cant (cross-level) realignment value as shown on the following Fig. 3.

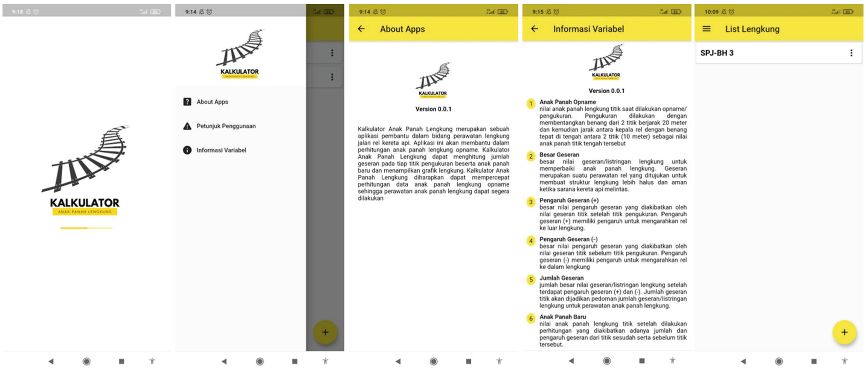

Fig. 2. Application Interface Design

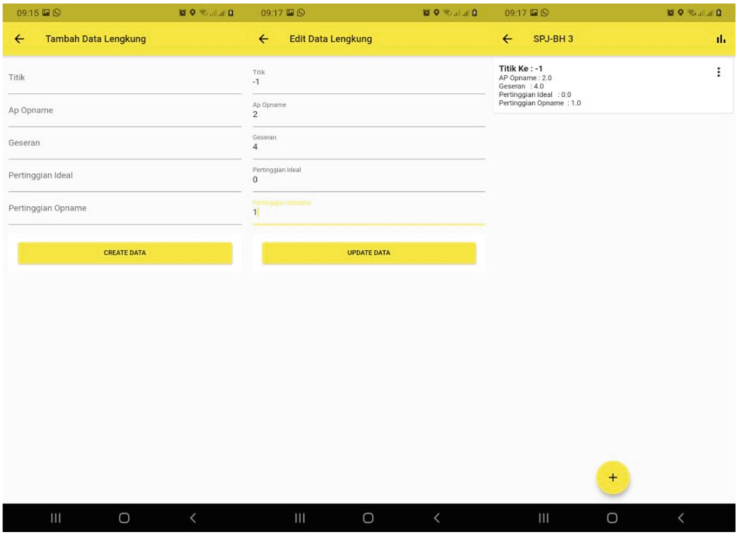

Fig. 3. Interface for versines and cant input data

3.2 Case Study of Curves Measurement

The application was tested using data from a curve from KM 24+014 to 24+091 between Sepanjang Station-Boharan Station Railroad in Surabaya with a Radius of curves of 5000 m as in the following Table 1.

From Table 1, the value for slew or realignment of the curves to fix the versine value aimed to make the curve geometry meet the ideal condition on the curves nameplate, which meets the requirement [8]. The realignment on a point would impact the nearest point of the versine, which will cause positive (+) slew effect when the rail moves out of the curves and a negative (−) slew effect when the rail moves inward to the centre of the curves. Total realignment is the cumulative realignment value from one point and the adjacent point of the curves. The new versine value was the total of versine measurement, adjacent slew effect, and realignment value. Table 1 also shows the number of measured cant and the number of ideal cant for the curves, which were calculated using Microsoft Excel. The calculation results can be displayed as a graph in the following Fig. 4.

Figure 4 shows the measured versine, new versine from the calculation, measured cant, and new cant from the analysis. The calculation was used to design the maintenance work for the curves consisting of realigning and lifting the track to get the ideal curves for the railway operation.

3.3 Versine and Cant Calculation with the Application

The measured versine and cant value, as in the Table 1 case study, was the input for the application. Figure 5 shows the Table which was produced by the mobile application. The value on the Table shows the same results as previously calculated by Microsoft Excel. This picture shows that the application meet the required data input and calculation of versines and cant value of the railway curves.

Table 1. Curves 3 SPJ-BH Calculation Data with Microsoft Excel

Spot Number	**−5**	**−4**	**−3**	**−2**	**−1**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Measured Versine	0	0	2	0	2	5	6	5	9	9	7	5	7	4	5	0	0	−1	0
Realignment	0	0	−1	2	4	8	15	22	22	22	22	17	6	−2	−7	−4	−2	0	0
Effect (+)	0	0.5	−1	−2	−4	−7.5	−11	−11	−11	−11	−8.5	−3	1	3.5	2	1	0	0	0
Effect (−)	0	0	0	0.5	−1	−2	−4	−7.5	−11	−11	−11	−11	−8.5	−3	1	3.5	2	1	0
Total Realignment	0	0,5	−2	0.5	−1	−1.5	0	3.5	0	0	2.5	3	−1.5	−1.5	−4	0.5	0	1	0
New Versine	0	0,5	0	0.5	1	3.5	6	8.5	9	9	9.5	8	5.5	2.5	1	0.5	0	0	0
Measured Cant	0	0	0	0	0	5	10	15	15	15	15	15	15	10	5	0	0	0	0
New Cant	0	0	0	−2	1	2	3	9	14	11	13	14	13	13	7	5	2	2	0

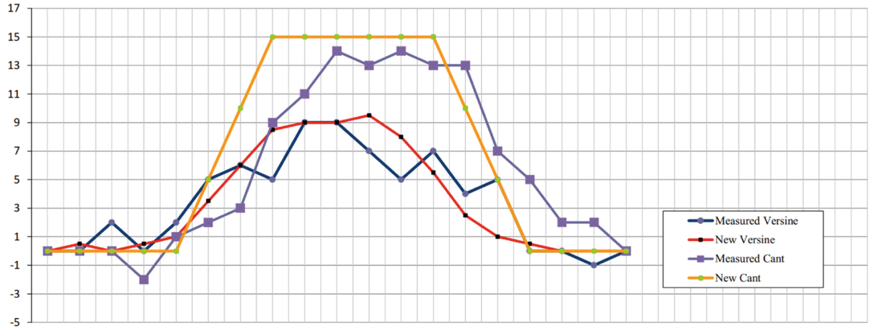

Fig. 4. Graphic of Versine and Cant value

No Titik	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7
AP Opname	0.0	0.0	2.0	0.0	2.0	5.0	6.0	5.0	9.0	9.0	7.0	5.0	7.0
Geseran	0.0	0.0	-1.0	2.0	4.0	8.0	15.0	22.0	22.0	22.0	22.0	17.0	6.0
P.Geseran(+)	-0.0	0.5	-1.0	-2.0	-4.0	-7.5	-11.0	-11.0	-11.0	-11.0	-8.5	-3.0	1.0
P.Geseran(-)	-0.0	-0.0	-0.0	0.5	-1.0	-2.0	-4.0	-7.5	-11.0	-11.0	-11.0	-11.0	-8.5
J.Geseran	0.0	0.5	-2.0	0.5	-1.0	-1.5	0.0	3.5	0.0	0.0	2.5	3.0	-1.5
AP Baru	0.0	0.5	0.0	0.5	1.0	3.5	6.0	8.5	9.0	9.0	9.5	8.0	5.5
Pertinggian Ideal	0.0	0.0	0.0	0.0	0.0	5.0	10.0	15.0	15.0	15.0	15.0	15.0	15.0
Pertinggian Opname	0.0	0.0	0.0	-2.0	1.0	2.0	3.0	9.0	14.0	11.0	13.0	14.0	13.0

Fig. 5. Data of Versine and Cant value from application

Along with the calculated Table, the mobile application also can produce a graphic of the curves, which consist of measured versine, new versine from the calculation, measured cant, and new cant from the calculation as previously created by Microsoft Excel. The graphic can be seen in Fig. 6.

Figure 6 shows that this mobile application can produce numeric and graphical information of the measured and planned versine and cant value from the curves case study. This application fulfilled the need for mobile tools to calculate and illustrate the railway curves immediately after the measurement was undertaken. This means the application can reduce the time and effort of calculating the curves and monitoring results at the office.

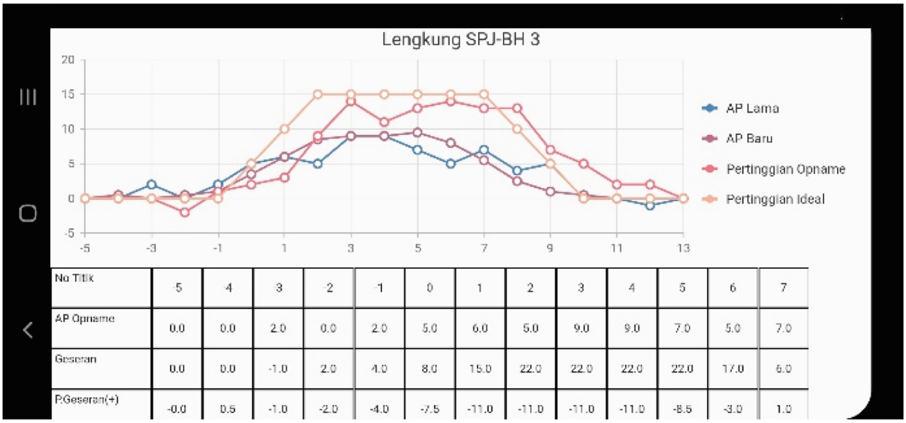

Fig. 6. Graphic of Versine and Cant Calculation by Application

4 Conclusion

This research succesfully created a mobile application for railway curves calculation. The aplication was built with a flutter framework with dart programming language by designing the application database, designing the features for the application, and testing the application function. The test result from the case study showed that Microsoft Excel and mobile applications produced the same result for data calculation and data illustration for curve maintenance which was demonstrated in the case study results. The results from the application can also be saved in a Microsoft Excel file for further maintenance office work. The application also can be used for all curves because there was no limit for the total number of versine, and it also worked well without internet access.

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