

Analysis and design of road and bridge infrastructure database using online system

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Abstract. A road database is an important component for observing a general picture of a road network, determination of treatment needs, road development and planning so that the roads in the road network in a city can receive treatment at the right time and action in accordance with its needs. The development of the road database system by the Office of Public Works of Palembang, Indonesia using Linux open source database platform, that is MySQL servers and application using the API (Application Protocol Interface) services provided by Google in order to represent the database as information in the form of a Google map. The developed menu was tailored to the needs of road maintenance management in Palembang including the menu input data, data view, minimum service standards, reporting and integration with national databases. Multi-level access into the developed system was applied to the users ranging from decision makers to field implementers. Since the development in 2014, the number of the recorded roads in Palembang City has been getting complete ranging from 952 roads with the road length of 618.9 km in 2014 to 1204 roads with the road length of 681.8 km in 2016. The number of recorded bridges increased from 125 bridges to 135 bridges in 2016. With the existing systems and data, the needs analysis of road maintenance based on the road conditions can be determined. In addition to the analysis of the road minimum service standards and integration with the national database system, the advantages and improvement necessity in the implementation of the system are discussed in this paper.

1 Introduction

Palembang City as a city of trade and services increasingly grows rapidly from time to time. Infrastructure construction to support the movement necessity keeps going on along with the city development. Palembang City faces the increasingly complex problems that must be addressed, particularly with regard to the provision of city transport infrastructure.

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Road database is an important component to provide an overview of road network, determine handling requirements, development and road planning so that the roads in the road network in a city will receive a handle at appropriate time and action according to the road necessity.

In 2014 a road data update was conducted in Palembang City. It was the update of road data in the road network and the road and bridge database system development using online system. The road and bridge database system is capable of providing an overview and details of the existing road and bridge network. It is an important device to support to determine the handling necessity, development and planning of roads and bridges in Palembang City.

The developed online database system refers to the road management needs of Palembang City and literature on the existing database management. Database development or studies on road and bridge database and road management system have been reported [1, 2, 3, 4].

The study aimed to analyze: 1) the development of online-based database system of roads and bridges and 2) the development of the advantages and improvement necessity of the developed database system.

2 Development of online database system

The online system for road and bridge infrastructure database was developed using information technology facilities such as the Internet and mobile devices. For the internet network, the system was built with the procurement of an online web server accommodating a database and a web-based application program. The database installed into a web server is a relational database holding all the data related to road and bridge infrastructures designed structurally, integratively, and easily developed. Web-based application program installed in a single location of a database server was used as a store of functions related to the entire business of data management process of road and bridge infrastructure and as a provider of web-based graphical interface to all system users. The mobile device was also used in this system that served as an additional medium for the interface user on the system. The developed online system network involved some hardwares connected through the internet in the form of a computer/PC client, mobile client devices, web servers and database servers. Architecture of online system network is given in Figure 1 below.

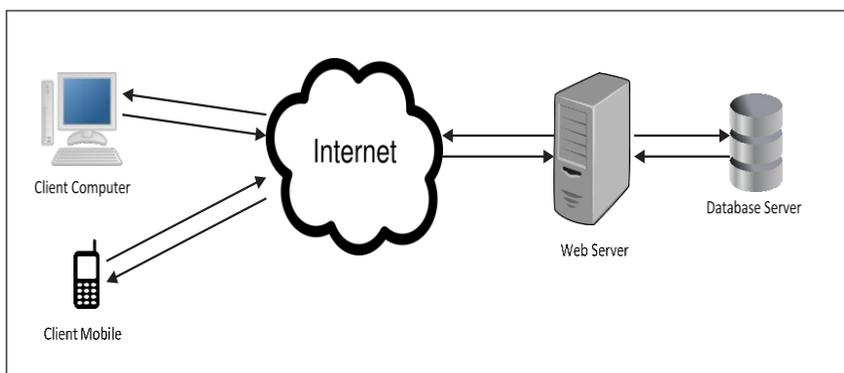


Fig. 1. Architecture of online system network

Some software aids that can be used in the online system are among other things:

- a. Web Server:
 - Linux Operating System
 - Apache web server

- PHP 5
- b. Database Server with MySQL 5
- c. Cloud Web Services: Google Maps API Services
- d. Client Computer: Internet Browser
- e. Client Mobile: OS Android dan GPS Tracking System

The online database system was designed using relational and integrated structure with the relational diagram given in Figure 2 as follows:

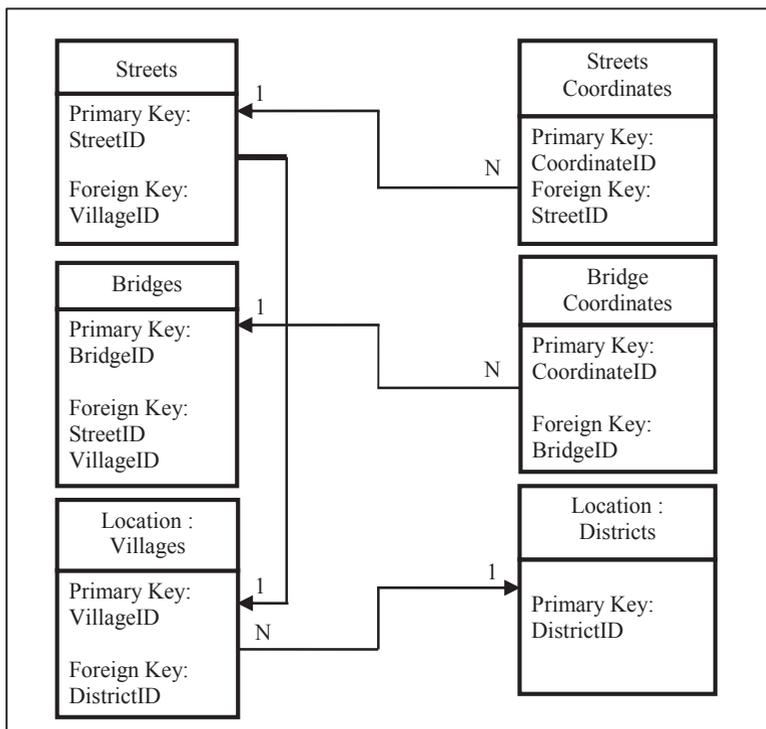


Fig. 2. Structure of online system database

3 Data management and implementation analysis

The concept of developed database system described in the menus contained in the online-based software of road and bridge database of Palembang City. They are input data menu, see the data, analysis of minimum service standard, report, handling history, integrated with national database and library. Database period is made annually in order to be able to update and monitor the development of road and bridge network data each year. In database development, the collected data of roads and bridges were, among others, data of inventory, coordinate, material types, and construction types as well as their conditions. Other collected data included data of roadsides, sidewalks, culverts, and other road necessities. All data were input into the system developed through the data input menu.

Menu of viewing the data is given in Figure 3 consisting of menus of viewing the data of roads, bridges, road networks, road conditions, networks of pavement-drainage-road shoulder, and culverts.

On the menu of viewing the data, one can see both the network and detailed data for each road such as the data of inventory, position, type and condition of the road. Figure 4 shows the examples of program output of a road segment.

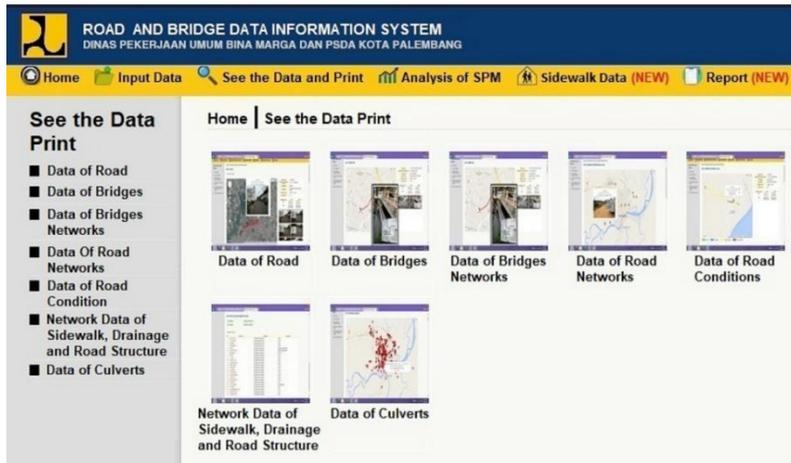


Fig. 3. Menu of viewing the data

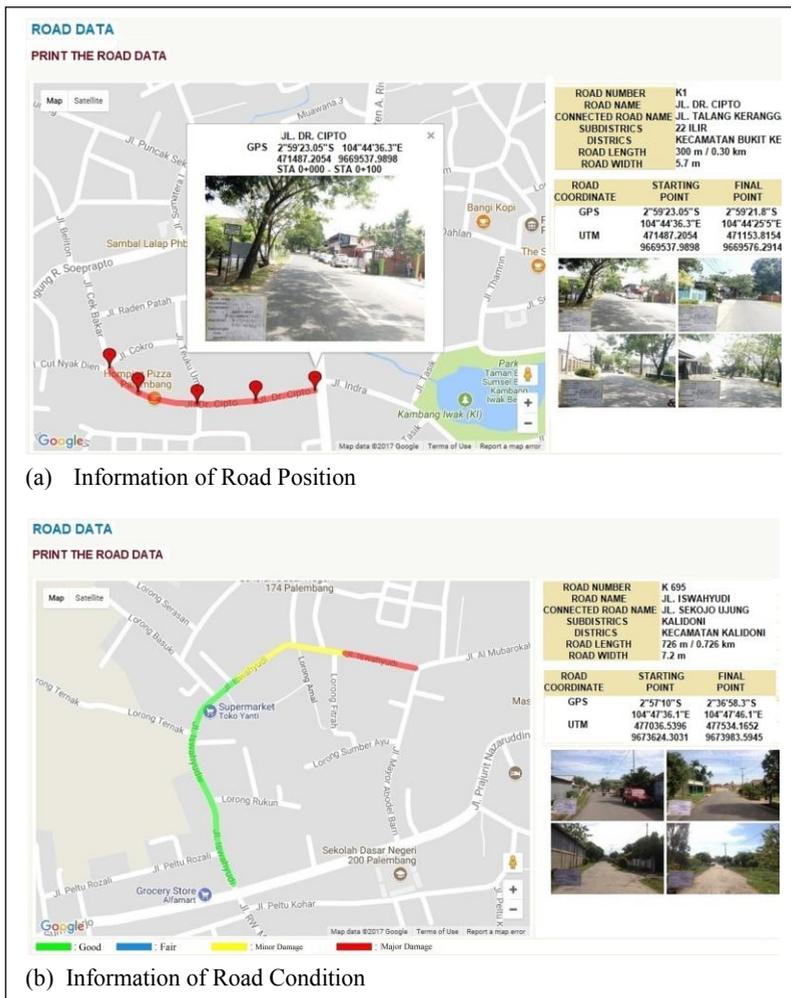


Fig. 4. Output for a road segment

Analysis of data on the annual development of the road network can be done, among others, to see developments of network conditions and types of pavement. The development of pavement types and network conditions in the Palembang City in 2014 and 2016 are shown in Figures 5 and 6. Figures 5 and 6 show that:

- Despite an increase in the number and length of the road segments of the recorded data from 952 roads of 618.9 km in 2014 to 1204 roads of 681.8 km in 2016, the percentage distribution order of pavement types did not change, that is asphalt concrete, concrete with asphalt surface, concrete, dirt road, and gravel. The existence of dirt and gravel roads resulted from the fact that the government of Palembang City kept constructing pioneer roads, particularly those in newly developing suburban regions.

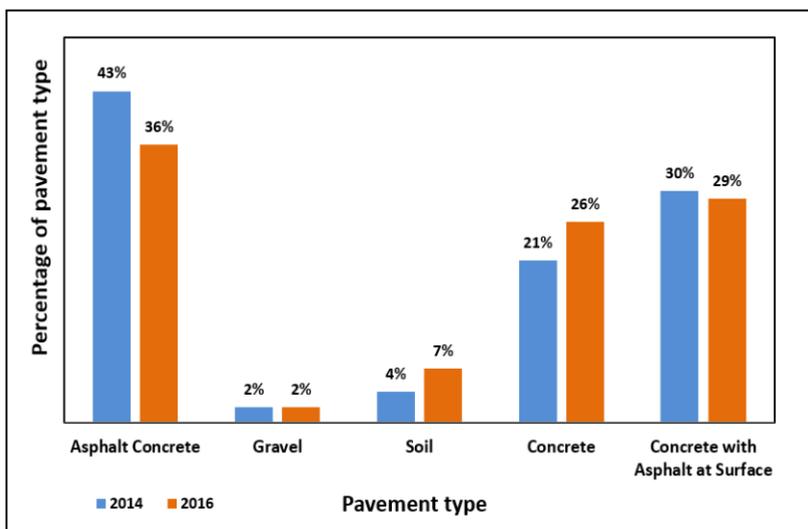


Fig. 5. Development of road pavement type

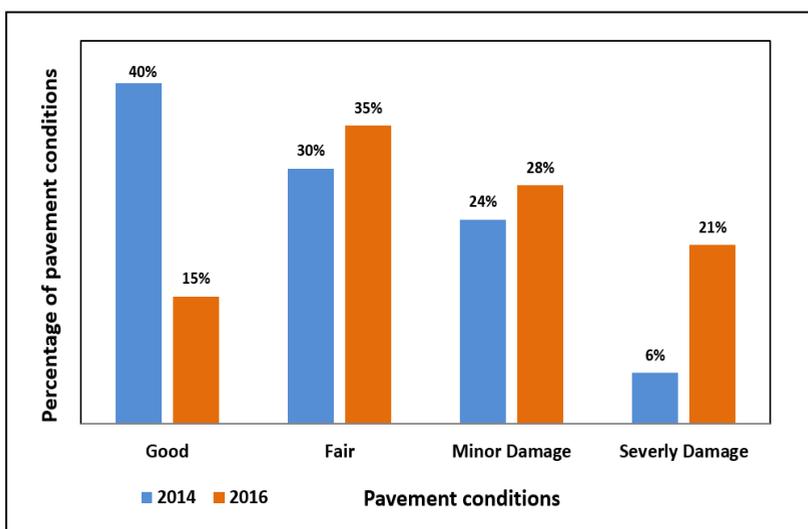


Fig. 6. Development of road network condition

- In 2016 the stable road condition (good, fair and minor damaged) was 78%, decreasing 16% compared with that of 2014. It indicates that there needs an immediate action to heavily damaged roads, although some of them occur in the pioneer roads constructed from dirt and gravel roads.

Until 2016 the number of bridges existing in Palembang City has been 156 bridges. The existing database is capable of showing the distribution of bridge locations, inventory data, bridge condition both in network and individually. The distribution of bridge locations in Palembang City on a road segment, bridge upper structure type and bridge condition is shown from Figures 7 to 10. Figures 9 and 10 show that:

- Most bridges in Palembang City have a concrete construction structure.
- Generally in 2016 there was a decline in the condition of bridges. Consequently, it is very critical to have the upkeep of the bridges whose bad conditions decline.

The results and analysis of road and bridge conditions both in network and individually can help the Office of Public Works in the upkeep program of roads and bridges in Palembang City.

The analysis of minimum service standard in the system developed is in accordance with the Regulation of Minister of Public Works of Republic of Indonesia No. 14/DRT/M/ 2010 on the minimum service standard of public works and spatial planning for achieving the minimum service standard [5]. The result of score output of the minimum service standard for accessibility, mobility, safety, road condition and speed is given in Table 1.

To improve the minimum service standard, the database system produces a list of road segments to be repaired in Palembang City. In 2016 as shown in Table 1, Palembang city will still have to increase the minimum service criteria of road network for mobility, safety, road conditions and speed.

Report menu in the database system is designed to produce a report according to the report format needed by the builder of Palembang City roads for both regional and national reporting.

Handling history menu is used to record the action of repair of road segments annually so that it can be recorded year after year. In the management of road maintenance, the data can be used for analysis of handling priority.

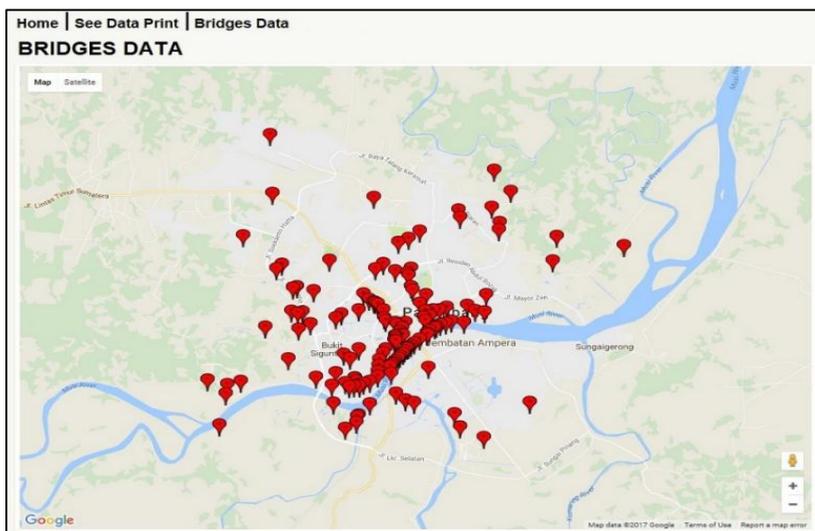


Fig. 7. Distribution of bridge locations in Palembang

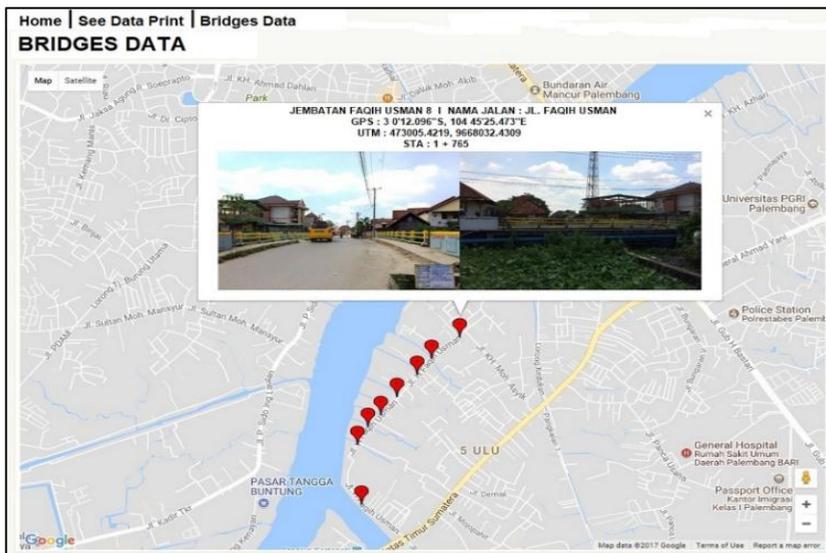


Fig. 8. Distribution of bridges on road segments

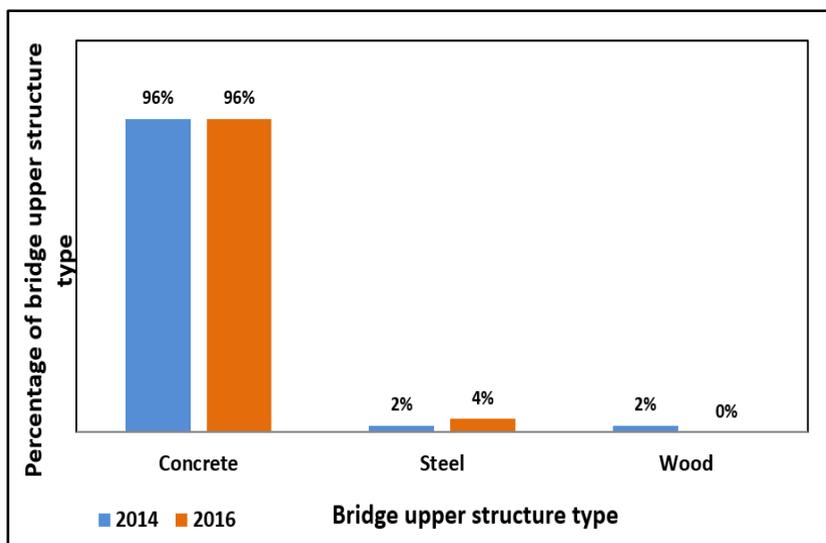


Fig. 9. Distribution of bridge upper structure type

Integration menu with national road database is used to prepare and upload road network data of Palembang City to national road database system. A complete road database of Palembang City at national level can be used by the central government to prepare a policy of road development in the regions.

After three years of running, the handling of the roads using the developed road database system has advantages, among other things:

- The road builder in Palembang City can easily have an overview of the network condition of roads and bridges.

Table 1. Standard score of minimum service

No	Minimum Service Criteria	Score	Standard	Remarks
1	Accessibility	1.62	1.5	High
2	Mobility	4.22	5	Need to improve
3	Safety	25.11	-	Need to improve
4	Road Condition	53.14	-	Need to improve
5	Speed	53.14	-	Need to improve

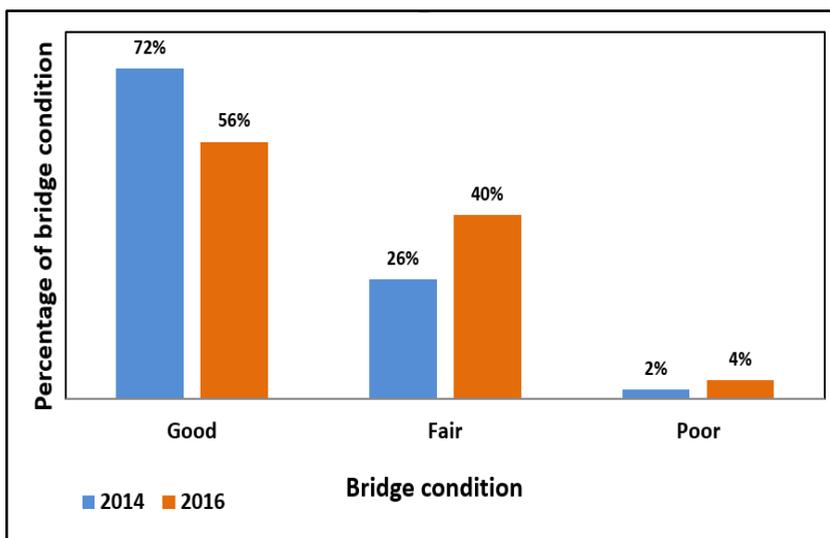


Fig. 10. Distribution of bridge condition

- The system can help road managers to view in detail the inventory data and conditions of each road and bridge so that an action can be executed fast and accurately.
- The above two mentioned can be conducted on other road components such as pavements and culverts.
- Due to the online-based system, the database system can help field technicians identify field problems by using cellular phone gadgets.
- The reporting system has been in accordance with the needed reporting format.

In a improvement of the existing database systems it showed that improvements in both data collection instruments for inventory data collection and the road condition used the practical tools that had a high degree of accuracy, given the road network of Palembang City is broad and complex.

4 Conclusions

The implementation of online-based road and bridge database system developed in 2014 indicates that the developed system is very helpful for road manager in looking at the overview of road and bridge network in Palembang City as well as helpful in preparing the

planning of road and bridge handling more accurately and effectively. In the future, considering broad and complex road condition of Palembang City, the act of perfecting the output of the existing database system will be on the data collection instruments both for inventory data and road condition by using highly accurate practical.

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