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Development of a Centralized Vehicle Maintenance Information System

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ABSTRACT

Motor vehicle maintenance is important for safety, performance, efficiency, and economy. Well-maintained vehicles have optimally functioning systems, reducing the risk of major damage and repair costs. For transportation businesses, routine maintenance ensures that vehicles are always ready for operation, maintaining profitability. Monitoring service history and predicting maintenance needs are necessary to avoid operational disruptions. Well-maintained vehicles are also more attractive to potential buyers, increasing their resale value in the market. Consistent maintenance not only extends the life of the vehicle, but also improves fuel efficiency and reduces emissions. To facilitate the process of monitoring and maintaining these vehicles, a system is needed that can be accessed on a computer or smartphone, both online and offline. This research is an R&D study that will develop a centralized vehicle maintenance information system. This research will analyse the requirements for monitoring and maintaining vehicles. Subsequently, the Centralized Vehicle Maintenance Information System (SIPEKAT) will be developed based on the results of the requirements analysis to serve as a system capable of monitoring and maintaining vehicles. Based on the results of the needs analysis, there is some information that needs to be displayed on this vehicle maintenance information system, including: 1) Information on the number of active vehicles. 2) Information on the number of vehicles that are running and also stopped. 3) Information on the number of vehicles undergoing maintenance/repairs. 4) Information on when owned vehicles will undergo maintenance/repairs. 5) Information on who is performing maintenance/repairs on the vehicle and the estimated completion time for maintenance/repairs. The Centralized Vehicle Maintenance Information System (SIPEKAT) has been developed and tested for functionality. The next step in the development of this information system is to make it accessible online.

1. Introduction

The importance of motor vehicle maintenance can be understood from various aspects, including safety, performance, efficiency, and economy. Good maintenance can improve driving safety. Well-maintained vehicles tend to have braking systems, lights, and other safety components that function optimally. Vehicles that receive regular maintenance tend to perform better. Clean oil, good air filters, and an efficient fuel system can help the engine operate properly. Thus, the vehicle will have better response to acceleration and handling. Regular maintenance can improve the

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vehicle's fuel efficiency. A clean engine and properly functioning components can optimize fuel consumption. This allows vehicle owners to save money and reduce their environmental impact due to lower emissions. Well-maintained vehicles are likely to have a longer service life. Owners who pay attention to preventive maintenance and quickly repair minor problems can prevent major damage, extend the life of their vehicles, and reduce the need to purchase new ones.

Performing routine maintenance tends to be more economical than replacing or repairing severely damaged components. Vehicle owners who regularly perform inspections and maintenance can avoid large repair costs that may arise due to negligence. Well-maintained vehicles have a higher resale value than poorly maintained vehicles. Good maintenance reflects the owner's care and responsibility towards their vehicle, making potential buyers more likely to be interested and willing to pay more for a well-maintained vehicle. Some regions require periodic inspections or emissions tests to ensure that vehicles meet safety and emissions standards. Routine maintenance helps ensure that vehicles continue to meet legal requirements and do not face legal issues.

Vehicle maintenance is very important and beneficial for transportation business operators. Transportation business operators usually have a large fleet or number of vehicles. Monitoring each unit requires more effort than for private vehicle owners. In addition, transportation business operators must ensure that their vehicles are operational whenever needed, as this will affect the company's profits. In the vehicle monitoring process, historical data or records of each unit and predictions of vehicle maintenance or repairs are required, which must be recorded neatly and clearly. The vehicle maintenance method still widely used by transportation companies today is periodic vehicle maintenance based on the age of the components.

To facilitate the process of monitoring and maintaining these vehicles, a system is needed that can be accessed on computers or smartphones, both online and offline. This research is an R&D study that will develop a centralized vehicle maintenance information system. This research will analyze the requirements for monitoring and maintaining vehicles. Subsequently, the Centralized Vehicle Maintenance Information System (SIPEKAT) will be developed based on the results of the requirements analysis to serve as a system capable of monitoring and maintaining vehicles.

Maintenance involves a combination of various activities with the aim of maintaining or repairing an item to achieve an acceptable condition. In a corporate context, maintenance refers to efforts to maintain facilities and carry out repairs in accordance with a predetermined plan [9]. Preventive maintenance is an activity carried out with the aim of preventing/removing the possibility of malfunctions/damage to machinery. Preventive maintenance is carried out without waiting for signs of damage or malfunction. For this reason, preventive maintenance is divided into three maintenance models, namely periodic maintenance, schedule maintenance, and condition-based maintenance.

Timely and structured vehicle maintenance management is important for companies that operate large fleets of vehicles. Routine vehicle maintenance, including preventive maintenance, can extend the service life of vehicles, improve fuel efficiency, and reduce the risk of major damage that requires high costs [1]. Monitoring vehicle service history is an important requirement for companies with large fleets. Good data management related to vehicle maintenance and usage history will facilitate the prediction of maintenance and repair needs [2]. Technology that can assist transportation businesses and vehicle owners in monitoring their vehicles is a solution to the challenges of vehicle maintenance management. The use of a centralized information system that integrates vehicle data, service history, and maintenance predictions can improve operational efficiency [3].

Research by Smith and Chang (2015) in the Journal of Vehicle Maintenance examined the effectiveness of vehicle maintenance management in commercial transport fleets. Their research

showed that time-based maintenance is often less efficient than condition-based maintenance. This is due to variations in vehicle usage time, which makes time-based maintenance schedules less accurate in identifying actual maintenance needs. Through condition-based management supported by sensor technology, they found that vehicle damage could be minimized, while maintenance time could also be optimized.

Research from Jones et al. (2018) in the International Journal of Automotive Technology provides insight into the importance of using Computerized Maintenance Management Systems (CMMS) in vehicle management. The study shows that CMMS systems can improve operational efficiency by monitoring vehicle maintenance history in real time. CMMS also enables automatic maintenance scheduling based on vehicle condition, thereby reducing the risk of downtime and optimizing vehicle lifespan. In addition, they found that companies that adopt CMMS tend to be able to reduce maintenance costs by up to 20% compared to companies that still use manual methods.

2. Method

This study utilized the Research and Development (R&D) method to develop a Centralized Vehicle Maintenance Information System (SIPEKAT). The research method consisted of several stages, namely: (1) Literature Study: In the initial stage, a literature review was conducted to understand the concepts of vehicle maintenance, management information systems, and user requirements in terms of vehicle maintenance and monitoring. This literature review aimed to provide a theoretical basis and guidance for system development. (2) Data Collection on Requirements: Data collection was carried out by observing transportation businesses that owned vehicle fleets. The data collected included information requirements related to vehicle maintenance, vehicle monitoring workflows, and difficulties encountered in routine maintenance. The analysis of this data aims to identify the key features required in the system. (3) System Requirements Analysis: Once user requirements data has been collected, a system requirements analysis is conducted. The aim is to design an optimal SIPEKAT structure for presenting information on the number of active vehicles, vehicle status, maintenance schedules, and technician management. (4) System Design and Development: The next stage is system design and development based on the results of the requirements analysis. The user interface is designed to be easy to operate by users. System development is carried out using web-based software that can be accessed offline and online with a computer or smartphone.

3. Results and Discussion

3.1. Results

The results of literature studies and observations conducted in this study were used as the basis for developing a centralized vehicle maintenance information system. The results of literature studies and observations in this study include: The importance of good and regular vehicle maintenance to maintain vehicle performance, safety and service life. Vehicle maintenance for the purpose of preventing damage can reduce the risk of major damage by up to 30%, which means a reduction in repair costs in the long term [4]. Proper vehicle maintenance can improve fuel efficiency and reduce exhaust emissions [5]. Good vehicle maintenance management, especially with the use of technology-based information systems, can increase operational efficiency by up to 25% [6]. An integrated vehicle maintenance management information system with maintenance schedules and vehicle tracking is very helpful in extending the service life of the vehicle fleet. [7].

Web-based and mobile vehicle maintenance information systems can make it easier for vehicle owners to access information related to their vehicles and also communicate with technicians in the field, thereby minimizing vehicle waiting times [8]. Vehicle maintenance information systems must be able to provide real-time data on vehicle status, maintenance history, and future maintenance needs [9]. The use of a vehicle maintenance information system with a predictive maintenance concept is essential for vehicle owners to predict maintenance needs based on the actual condition of the vehicle rather than a fixed schedule [10]. A good information system must be able to adapt to dynamic business needs, including integration with other systems such as GPS and route tracking [11].

The results of the requirements analysis for the centralized vehicle maintenance information system were obtained based on literature studies and observations. The following are the results of the requirements analysis that need to be presented in the centralized vehicle maintenance information system, including: Information on the number of active vehicle units, Information on the number of vehicles that are running and also stopped, Information on the number of vehicles undergoing maintenance/repairs, Information on the predicted timing of maintenance/repairs for owned vehicles, Information on who is performing vehicle maintenance/repairs and the estimated completion time for maintenance/repairs.

Design and Development of a Centralized Vehicle Maintenance Information System

The equipment required for the design and development of a centralized Vehicle Maintenance information system can be divided into two categories: hardware and software. The hardware required includes: (1) Computer, (2) Mouse as an interface device, (3) Keyboard as an interface device, (4) Router for internet network. Meanwhile, the software requirements include: (1) Windows as the operating system, (2) Xampp x64-7.3.29-2-VC15 as the server, (3) Google Chrome as the web browser, (4) Sublime Text 3 as the text editor.

Centralized Vehicle Maintenance Information System

Login information as a requirement for account owner security can be seen in Figure 1.

Figure 1. SiPeKaT login information

The home page displays information about the number of active vehicles, vehicles that are running and stopped, vehicles that are undergoing maintenance and repairs, estimates for the nearest vehicle maintenance, and details of vehicles undergoing maintenance, as shown in Figure 2.

Figure 2. SiPeKaT home page display

Information regarding the number of vehicles currently moving and stopped can be seen in Figure 3.

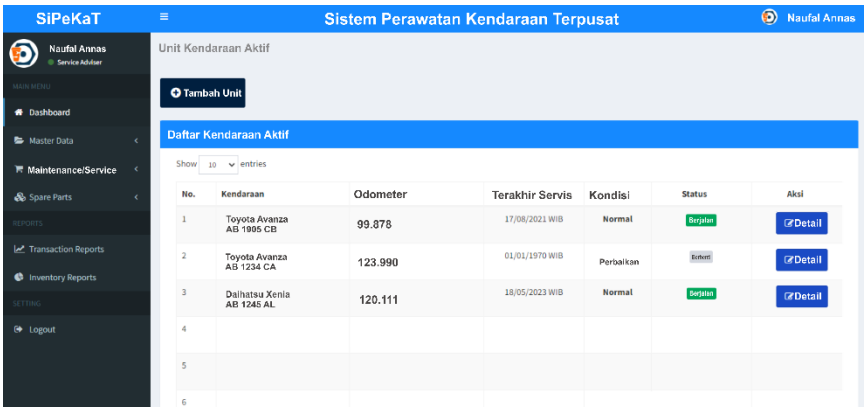

Figure 3. Vehicle Status Display

Information on who is working on vehicle maintenance/repairs and the estimated completion time can be seen in Figure 4.

Figure 4. Display of information about vehicles currently being repaired

3.2. Discussion

This centralized vehicle maintenance information system can improve operational efficiency, enabling fleet management to monitor vehicles in real time, reduce manual errors in record keeping, and provide a clear overview of each vehicle's status. Features such as upcoming maintenance

notifications, vehicle status (active, running, or stopped), and maintenance history allow users to take timely maintenance actions, thereby minimizing the risk of vehicle breakdowns during operation.

The implementation of a predictive system that monitors vehicle conditions and provides information on upcoming maintenance can minimize major damage that usually incurs high repair costs. Centralized vehicle maintenance data enables more effective management of the entire vehicle fleet on a single platform. This creates transparency in operations and increases accountability among the technicians involved.

As an evaluation of this Centralized Vehicle Maintenance Information system, if in the future it can be implemented online and also integrated with GPS tracking technology, it will be a step that can improve the system's ability to provide more comprehensive data.

4. Conclusions

The Centralized Vehicle Maintenance Information System (SIPEKAT) was developed to improve operational efficiency, reduce maintenance costs, and facilitate fleet monitoring. This system enables real-time vehicle management, with features such as maintenance schedules, service history, and technician management, although online access needs to be optimised, including integration with GPS tracking technology to improve the efficiency and effectiveness of vehicle maintenance.

Conflict of interest

The authors declare no conflict of interest.

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