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Web-Based Tire Check Application Development

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Abstract - This study investigates the development of a web-based application called Tire Check that can monitor vehicle tire pressure in real-time. This application aims to improve driving safety by providing up-to-date information on tire pressure conditions, which are a major factor causing traffic accidents in Indonesia. This application uses the MPX5700 sensor to measure tire pressure and connects it to a tire pressure monitoring system (TPMS). Analysis, design, implementation, and testing are part of the Waterfall methodology in software development. This application is built with the Laravel framework, using HTML, CSS, and PHP. Its main features include low tire pressure warnings, optimal tire pressure recommendations, and a simple and easy-to-understand user interface. The test results show that the application operates well and can detect tire pressure with 90% accuracy. To ensure that all features work as expected, testing is carried out using the black-box method with positive and negative scenarios. This application reduces the risk of accidents due to flat or burst tires by monitoring tire conditions without manual measuring tools. In addition, additional features such as tire temperature monitoring and compatibility with iOS devices have been developed.

Keywords :
Tire Pressure Monitoring;
System (TPMS);
MPX5700;
Laravel;
Web Application;
Tire Pressure;

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1. INTRODUCTION

Tires function to transfer the force of vehicle motion and minimize the strength of vibrations from uneven road surfaces. Tires also hold the entire weight of the vehicle and transfer braking forces [1]. With the number of cases increasing every year, traffic accidents are one of the highest causes of death in Indonesia [2]. found that problems with vehicle tires, such as flat or burst tires, cause many accidents.

Inappropriate tire pressure can reduce vehicle stability, reduce braking efficiency, accelerate tire wear, and increase the amount of fuel used. This shows how important it is to monitor tire pressure regularly and properly to reduce accidents caused by poor tires. Because it requires special measuring instruments and driver awareness to perform regular checks, manual tire pressure monitoring is still considered inefficient. This is a problem, especially for drivers who often neglect tire maintenance or do not know the importance of keeping tire pressure in the best condition. Tire pressure monitoring systems (TPMS) have the ability to track tire pressure in real-time and provide alerts in case of dangerous pressure drops. This system improves driving safety and makes it easier to manage tire conditions.

The purpose of this study is to create a web-based application integrated with *TPMS* sensors, especially the *MPX5700 sensor*, to monitor tire pressure in real-time. This application will display tire pressure information and also provide warnings and suggestions for tire maintenance according to the type of vehicle. This application is designed to be easy to use by various drivers using the *Laravel, HTML, CSS, and JavaScript frameworks*. It is hoped that this development will increase driver awareness of the importance of maintaining tire pressure and reduce the number of traffic accidents caused by tire problems.

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2. LITERATURE REVIEW

1. In this research, references from national and international research within the last ten years are used to build a web-based Tire Check application that can monitor tire pressure in real-time. Previous studies have shown that tire problems such as improper tire pressure are the main cause of traffic accidents in Indonesia. Tire pressure mismatch is a major factor affecting traffic accidents, according to research conducted by [2].

2. In addition, research conducted by [3] used the

MPX5700AP sensor to track tire pressure. This sensor sends data to a smartphone to monitor data in real-time.

3. [4] study used the *Fuzzy Tsukamoto method* to improve the accuracy of real-time tire pressure detection. The test results showed an accuracy rate of 85% in determining tire condition.

4. Furthermore, recent research by [5] highlighted the effectiveness of using IoT technology with *MPX5700AP sensors* to improve driving safety through tire pressure monitoring. Based on these references, the development of this Tire Check application utilizes similar technology with an emphasis on the integration of the *MPX5700 sensor* and the Tire Pressure Monitoring System (TPMS) to provide notifications and maintenance recommendations to users.

This research aims to address the problem of lack of driver awareness of the importance of maintaining optimal tire pressure. This application is expected to make it easier for drivers to monitor tire pressure in real-time, reduce the risk of accidents due to flat or burst tires, and improve fuel efficiency. With a user-friendly interface design, the app can be used by a wide range of people without requiring special technical skills. Operationalization of the concept involves an *MPX5700 sensor* for pressure measurement combined with a web-based notification system, which will provide alerts when tire pressure falls below a specified threshold. The concept has an *MPX5700 sensor* to measure pressure and a web-based notification system that will provide alerts when tire pressure falls below a certain threshold.

3. METHODOLOGY

This research uses the Waterfall software development method, which includes the stages of analysis, design, implementation, testing, and maintenance. This method was chosen because it provides a systematic and organized structure, where each stage must be completed before moving on to the next stage.

The analysis stage includes finding problems related to monitoring vehicle tire pressure, such as the difficulty of users using manual measuring instruments and the lack of awareness of the importance of maintaining tire pressure. Analysis was conducted to determine the required features, such as real-time monitoring, alert notifications, and optimal tire pressure recommendations.

In the *design stage, flowcharts, UML diagrams, and user interface designs* were created. Use case and activity diagrams were created to show the interaction between the user and the system. The database structure is intended to store user, tire pressure, and vehicle data.

The implementation phase begins with creating a web-based application using the *Laravel framework*, which uses *HTML, CSS, and PHP*. The application is integrated with an *MPX5700 sensor* to measure tire pressure in real-time. Data from the sensor is sent to the server and displayed in the web interface.

In the testing phase, the *black-box testing* method was used to test the functionality of the application based on positive and negative scenarios. Tests were conducted to ensure that all application features, including login, registration, tire pressure monitoring, and notifications, performed as expected.

To ensure that the development process could be evaluated and improved, the results of each stage were thoroughly documented.

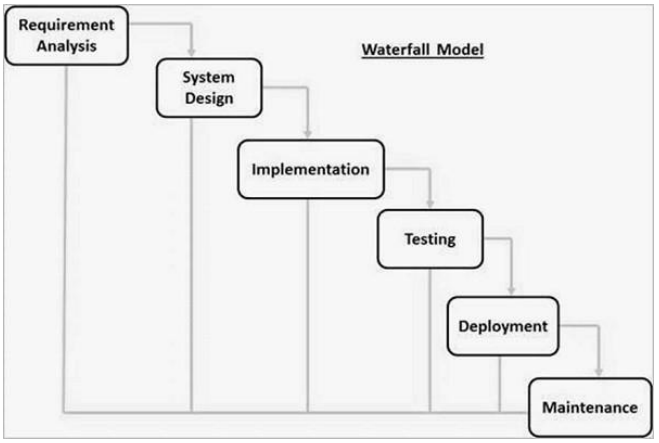

Figure 1. Waterfall Model

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Usecase

Users are authorized to access the profile, settings, vehicle, tire data, information, and pressure menus. See Figure 2.

Login
User can login to the system by using valid credentials.

Register
Users can register to the system.

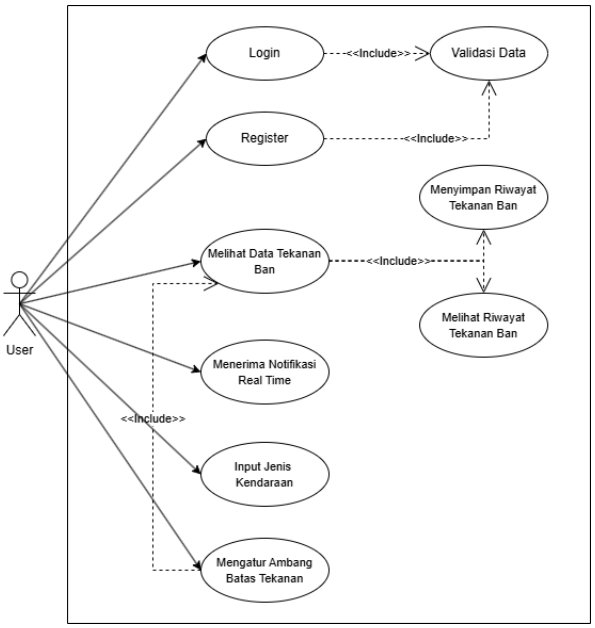
View Tire Pressure Data
Users can view the current tire pressure data sent by the sensor.

View Tire Pressure History
User can view previously saved tire pressure history.

Receive Real Time Notification
The system sends a real-time notification when the tire pressure is below the threshold.

Vehicle Type Input
Users can input the vehicle type so that the system can adjust the tire pressure setting.

Setting the Pressure Threshold
User can set the desired tire pressure threshold.



Class Diagram

User
Attributes:
userID: Unique ID for the user.
username: User name.
password: User password.
email: User email address.
Methods:
login(username: String, password: String): Boolean: Verifies user credentials to login.
register(username: String, password: String, email: String): Boolean: Registers a new user to the system.

Vehicle
Attributes:
vehicleID: Unique ID for the vehicle.
userID: ID of the user who owns the vehicle.
type: Type of vehicle (example: car, motorcycle).
model: Model of the vehicle.
Methods:
inputVehicleType(type: String, model: String): void: Inputs the type and model of the vehicle.

TirePressureData
Attributes:
dataID: ID of the tire pressure data.
userID: ID of the user who owns this data.
currentPressure: Current tire pressure.
timestamp: Time the tire pressure data was taken.
Methods:
viewCurrentPressure(): Float: View the current tire pressure.
savePressureData(pressure: Float): void: Saves tire pressure data to the system.
viewPressureHistory(): List<Float>: View tire pressure history.

PressureHistory
Attributes:
historyID: ID for the pressure history data.
userID: ID of the user associated with the pressure history.
pressure: Tire pressure data.
timestamp: Time the history data was recorded.
Methods:
getPressureHistory(): List<Float>: Gets a list of tire pressure history.

Notification
Attributes:
notificationID: Notification ID.
userID: ID of the user who received the notification.
threshold: Pressure threshold.
message: Notification message.
timestamp: Time the notification was sent.
Methods:
setThreshold(threshold: Float): void: Sets the threshold for tire pressure.
sendNotification(currentPressure: Float): void: Sends a notification when the tire pressure exceeds the threshold.

PressureThreshold
Attributes:
thresholdID: ID for setting the threshold.
userID: ID of the user who set the threshold.
lowerLimit: Lower pressure limit.
upperLimit: Upper pressure limit.
Methods:
setLowerLimit(limit: Float): void: Sets the lower pressure limit.
setUpperLimit(limit: Float): void: Sets the upper pressure limit.
Relationships Between Classes
User - Vehicle

Relationship: 1 to many (1 user can have many vehicles).
Type: owns.
User - TirePressureData

Relationship: 1 to many (1 user can have many tire pressure data).
Type: accesses.
User - PressureHistory

Relationship: 1 to many (1 user can have many tire pressure histories).
Type: records.
User - Notification

Relationship: 1 to many (1 user can receive many notifications).
Type: receives.
User - PressureThreshold

Relationship: 1 to 1 (1 user has 1 pressure threshold setting).
Type: configures.

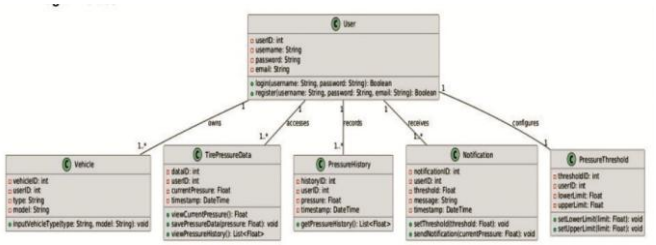


Figure 3. Diagram Class

Database Diagram

User

- **Primary Key**: userID

Vehicle

- **Primary Key**: vehicleID
- **Foreign Key**: userID

TirePressureData

- **Primary Key**: dataID
- **Foreign Key**: userID

PressureHistory

- **Primary Key**: historyID
- **Foreign Key**: userID

Notification

- **Primary Key**: notificationID
- **Foreign Key**: userID

PressureThreshold

- **Primary Key**: thresholdID
- **Foreign Key**: userID

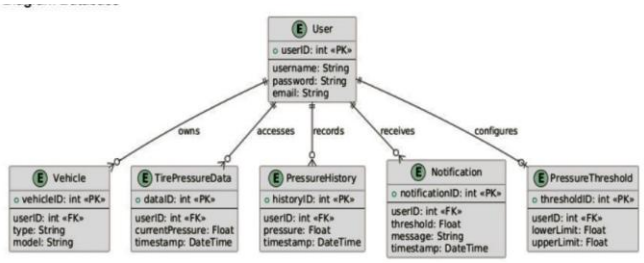


Figure 4. Database Diagram

4. RESULTS AND DISCUSSION

This tire check application system is designed in a web-based application. The process is divided into two, namely *Backend* and *Frontend*. The backend process uses the *Laravel framework* with the *PHP* programming language, for the frontend using *HTML*, *CSS* and *Javascript*. The source code that will be included is the source code for the dashboard, login, registration, and home page features.

Balckbox Testing

Positive testing

Tabe 1. Positive Testing

No	Fitur yang diuji	Skenario Pengujian	Hasil Diharapkan	Hasil Pengujian	Kesimpulan
1	Fitur Registrasi	Regist dengan akun yang belum terdaftar	Output berupa 'akun berhasil di daftarkan.'	Output berupa 'akun berhasil di daftarkan.	Passed
2	Fitur Login	Login dengan akun yang sudah terdaftar	Output berupa 'proses login berhasil' dan diarahkan ke halaman utama	Output berupa 'proses login berhasil' dan diarahkan ke halaman utama	Passed
3	Fitur Vehicle	Input: Merk: Fortuner Type: SUV Year: 2023 Engine: 2694 cc	Output berupa 'Kendaraan berhasil di input'	Output berupa 'Kendaraan berhasil di input'	Passed
4	Fitur Tire Data	Melihat kondisi tekanan ban saat ini	Menampilkan data tekanan saat ini di menu 'Right Now'	Menampilkan data tekanan saat ini di menu 'Right Now'	Passed
5	Fitur Information	Melihat informasi terkini yang berhubungan dengan ban kendaraan	Menampilkan sejumlah informasi yang terkait dengan ban	Menampilkan sejumlah informasi yang terkait dengan ban	Passed
6	Fitur Pressure	Membuat tekanan ban sesuai keinginan pada menu 'recommendation'	Output berupa 'tekanan ban berhasil diperbarui'	Output berupa 'tekanan ban berhasil diperbarui'	Passed

Negative Testing

Table 2. Negative Testing

No	Fitur yang diuji	Skenario Pengujian	Hasil Diharapkan	Hasil Pengujian	Kesimpula
1	Fitur Registrasi	Regist dengan akun yang sudah terdaftar	Output berupa 'akun sudah terdaftarkan, silahkan login.'	Output berupa 'akun sudah terdaftarkan, silahkan login.'	Passed
2	Fitur Login	Login dengan akun yang belum terdaftar	Output berupa 'akun belum terdaftarkan, silahkan melakukan registrasi'	Output berupa 'akun belum terdaftarkan, silahkan melakukan registrasi'	Passed
3	Fitur Vehicle	Input: Merk: Fortuner Type: sedan Year: 2023 Engine: 2694 cc	Output berupa 'Kendaraan tidak valid. isi dengan benar'	Output berupa 'Kendaraan tidak valid. isi dengan benar'	Passed
4	Fitur Tire Data	-	-	-	-
5	Fitur Information	Search 'makanan terfavorit'	Output berupa 'informasi tidak tersedia'	Output berupa 'informasi tidak tersedia'	Passed
6	Fitur Pressure	Membuat tekanan ban menjadi 0psi pada menu 'recommendation'	Output berupa 'tekanan ban terlalu rendah'	Output berupa 'tekanan ban terlalu rendah'	Passed

Based on the results of the testing stages using the blackbox method, method to all functions in the Tire Check application, it can be concluded that:

- All systems work and run well, starting from the login process to logging out.The results obtained have fulfilled expectations of the author.
- The accuracy rate of the MPX5700 sensor is very satisfactory, which is about 90%.

UI/UX Design

The following is a design for a web-based application that has been created.

Figure 5. Initial View

Figure 6. Regist

Figure 7. Login

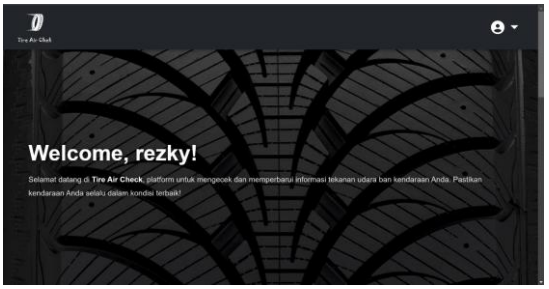


Figure 8. Dashboard

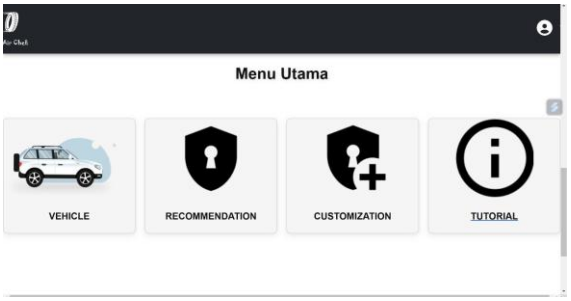


Figure 9. Main Menu

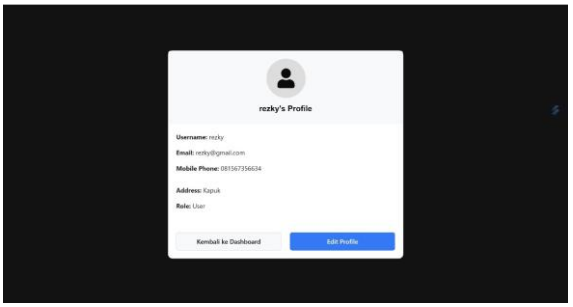


Figure 10. Profile

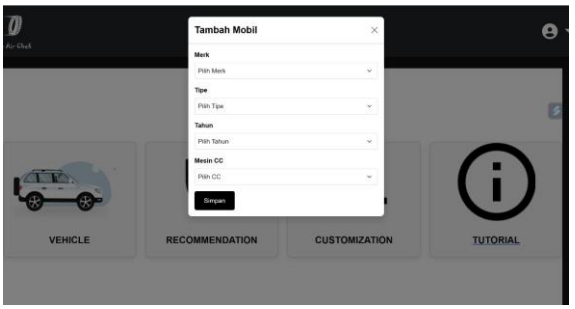


Figure 11. Vehicle (Car)

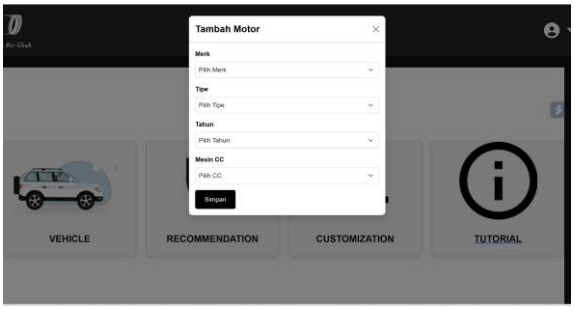


Figure 12. Vehicle (Motorcycle)

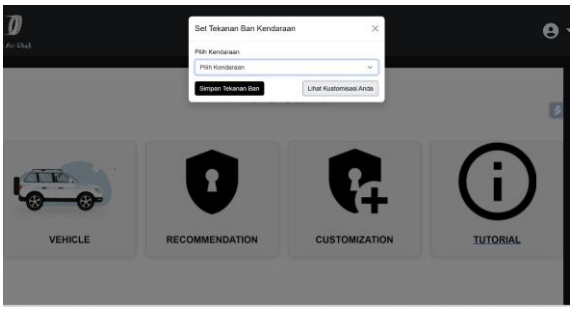


Figure 13. Customization

5. CONCLUSION

Based on the test results and the description above, we conclude that this web-based application is successfully integrated with the tyre pressure sensor (TPMS) and allows the user to use the application is successfully integrated with the tyre pressure sensor (TPMS) and allows the drivers to monitor tyre pressure in real-time. This application also provides a warning related to flat tyres. In application development, the Waterfall method allows for a structured and documented structured and well-documented process. This application is expected to improve driving safety and reduce traffic accidents in Indonesia caused by tyre problems, despite some technical challenges.problems with tyres, although there are some technical challenges. So that the objectives and benefits of this research can be achieved.

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