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Internet of Things (IoT) Innovation and Application to Intelligent Governance Systems: A Case Study on DISHUB for Transport Vehicles

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***Abstract*— Vehicles can be used to facilitate humans in carrying out their daily activities. Motorized vehicles are divided into 3: land, sea, and air. Apart from the many benefits that can be obtained, motorized vehicles have dangers related to high-risk accidents. The highest cause of motorized vehicle accidents on land is road damage due to overload vehicles. Brake failure due to overload vehicles also contributes to vehicle accidents. This research aims to create an Internet of Things (IoT) based application to detect motorized vehicle load conditions. It was combined with several other technologies to produce a tool for detecting motor vehicle load conditions. The Extreme Programming Method is being used in this research. The Extreme Programming method is considered more suitable for completing this research because the communication with stakeholders is quite different. The Extreme Programming Method enables it to go back to the next step if discrepancies are encountered in making the system. The result of this research is an IoT-based tool called e-overload. It can detect vehicle loads, provide information for the drivers, and inform the results to related officers at the same time. E-overload tool will enable the drivers to get real-time information on the load on their vehicles. Officers will get additional evidence and the latest position of the vehicle to carry out actions against motorists who operate their vehicles with excessive loads.**

***Keywords*— IoT; department of transportation; transport; GPS tracker; real-time database.**

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I. INTRODUCTION

Motorized Vehicles are a technology present in the world community, especially in Indonesia. Motorized vehicles are very effective and efficient for traveling even far places. Vehicles are used to make it easier for humans to carry out daily activities. Motor vehicles are divided into land, sea, and air. Land Vehicles that can transport goods anywhere are Goods Vehicles, namely Pickup Cars, Loaded Trucks, and Cooperating Trucks. By having the load capacity of each of these vehicles, they have been taken into account by each dealer. Based on the Regulation of the Minister of Transportation of the Republic of Indonesia number PM 60 of 2019 concerning the implementation of goods transportation with motorized vehicles on the road, the Loaded Transportation Power obtained by the road on the highway is a vehicle with a load capacity that factory standards have measured. The Ministry of Transportation issued new provisions regarding open and closed freight vehicle tubs [1]. As for Trucks and Their Load Capacity is as follows: Trenton Wing Trenton,000Kg), Trenton (15,000Kg), Fuso Weight (8,000Kg), Fuso Light (5,000Kg), Double Engkel (4,000Kg), Engkel Box (2,200Kg), Small Box (800Kg), Pickup (800Kg), Van (720Kg), and Economy (150Kg) [2].

The cause of accidents and damaged roads in Indonesia is a loaded vehicle that exceeds the load capacity that the dealer has determined. The excess load causes damaged and bumpy roads, and excess loads cause brake failure on trucks, as in Figure 1.

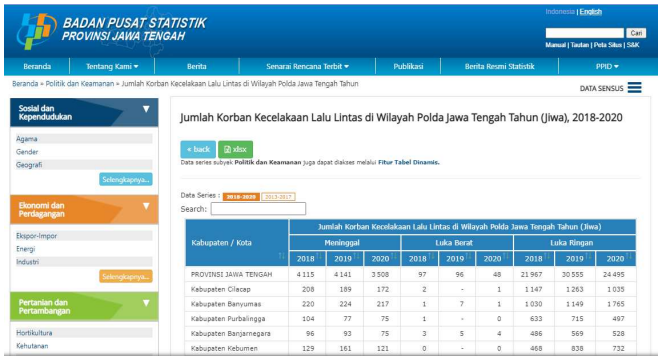


Fig. 1 BPS Accident Data [4]

According to BPS data from 2018 to 2020 [3], in Central Java Province, accident victims died as many as 11,764 people, major injuries as many as 241 people, and minor injuries as many as 77,017 people.[4]. The data above shows that there are still very many accident rates on the road. To prevent road accidents, the latest ideas and technologies are needed that can reduce the rate of road accidents. The Transportation[5]–[7] Agency is the implementing element of Government Affairs in the field of transportation [8]which is the regional authority, one of the duties of the transportation service is to act and give directions to motorists so that carrying goods, does not exceed the load.

The Internet of Things (IoT) [9] is an invention that can solve existing problems by combining technology and social impact. By applying IoT technology to loaded vehicles [10], it is hoped that it will be able to reduce the rate of accidents on the road, especially in the Banyumas area. The Banyumas Regency Transportation Office has disseminated the IoT technology. Innovation and Application of the Internet of Things (IoT), which Smart Government Systems support subject to the use of Mobile Phone technology for monitoring vehicles using Smart Phones GPS [11], [12]. Trackers are used to seeing Vehicle Locations. Realtime Databases are used to find out data from Vehicles, Load Counter Tools used to measure the maximum capacity of a loaded vehicle; with the application of this innovation, hopefully, the level of road damage and accidents can be reduced. Based on this background, there is a need for innovations that can help the government overcome damaged roads and accident rates on highways by using a monitored and integrated system with the Local Transportation Agency.

II. Materials and Method

A. Research Method

The subject of research, in this case, is e-overload as a medium to make it easier for officers of the Department of Transportation and motorists to act and comply with applicable regulations in transporting goods or objects on the highway. The several stages of planning are as follows: the first stage is the planning stage, where this stage, preparation, literature study, and problem formulation are carried out. The second stage is the data collection stage through observation, interviews, questionnaires, and documentation, as well as the processing of the data that has been obtained. The third stage is the analysis and discussion stage. At this stage, system analysis, system design, and design, coding, implementation, testing, and evaluation of the system applied will be carried out. The fourth stage is the documentation stage of the research results.

B. System Development Methods

The system development method carried out in this study is the Extreme Programming (XP) method. The Extreme Programming method is often also known as the XP method. Kent Beck, a software engineering expert, initiated this method. Extreme programming is a software development model that simplifies the different stages of system development to be more efficient, adaptive, and flexible [13].

The Extreme Programming [14]method is a software development concept that adheres to simplicity, communication, feedback, and courage. Extreme Programming tends to use an object-oriented approach and is appropriate to use when the team is faced with unclear requirements or in the event of a very rapid change in requirements. The Extreme Programming method is the most suitable method for making website-based stunting prevention convergence management and reporting applications because it is done with a short work process. The use of the XP[15] method is very helpful in the application development process because the Kembaran District directly supervises the application creation process by providing feedback and establishing effective communication to reduce obstacles to the application creation process. The stages carried out are planning, design, coding, and testing.

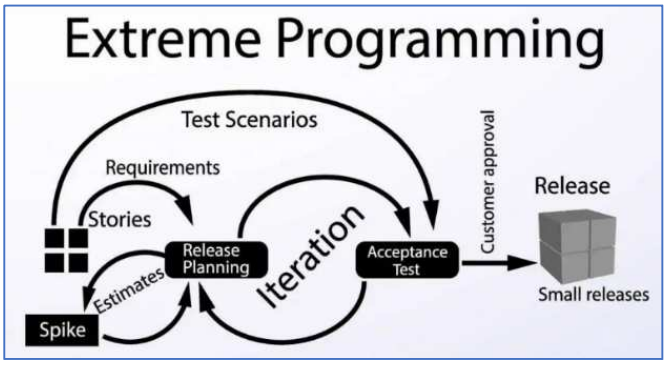


Fig. 1 Extreme Programming (XP) Method Process [16]

Based on Figure 2, the stages that must be passed by the Extreme Programming method in research, namely:

1) Planning: The Planning [17] stage is carried out by collecting the need to understand the context of the application management, reporting the convergence of stunting prevention to be created, and obtaining the output of the application and the main features and functions in the application. At this stage, researchers collecting performs data through observation and interviews. This stage creates a system flow for the subdistrict and gives priority values based on overall features or functions afterward.

2) Design: The Design [18] stage is carried out by making a simple design regarding the development of management applications and reporting the convergence of stunting prevention which will then be carried out by making a class diagram. Design in the system flow is made in an object-oriented context. This design uses a Spike Solution, where the design is made directly to its destination. Extreme Programming also supports refactoring where the system software is changed according to needs and simplified, and the results of the code do not change. At this stage, the author designs the application's user interface based on the previous stage's results.

3) Program Code Writing (Coding): The coding [19] stage in XP begins with building a series of unit tests. After that, the development will focus on implementing it. Coding website applications using Arduino and Android using MySQL databases [20]. Re-coding is done if the coding results are found to be problems or bugs and will immediately make system improvements to the application. There are pair programming activities at the coding stage, namely coding in

pairs. However, this study was not carried out because this study focused on individual research, so the application design process was carried out individually. This stage is the stage of creating a system concerning the plans and designs that have been made.

4) Testing: The testing stage [21], [22] is the final stage to get system's reliability test results. Application testing aims to find out the errors that may occur if the application is already in the hands of the user. This stage is carried out by testing the coding of the application using a unit test, namely by testing black box testing. The final coding results that have been tested through unit tests are then tested by agencies using beta testing. The results of this test determine whether the application can be released or not. The application is declared ready for release if the coding results have been approved by the agency, stating that the application is worthy of release, but if there is still input for suggestions or improvements, it will be re-coding to fix the existing problem. Beta testing [23] is carried out by use by the Transportation Agency. Testing focuses on the overall test that can be viewed and reviewed by the user. The test results can also result in adding a new system to the system that has been created (an application that has passed the coding test), where the developer will do additional planning and design of the application. Money is then coded on the system's flow until the application passes the test.

III. Result and Discussion

A. Planning

The activities carried out in the planning process are as follows.

1) E-overload Business Process: Figure 3 describes the business process of an e-overload application. The business processes in question are as follows: Actors involved in the system are Vehicle Drivers, Transportation [24] Service Officers in the Field, and Transportation Service Officers at the office. Officers of the Department of Transportation in the Field and Officers of the Department of Transportation in the Office.

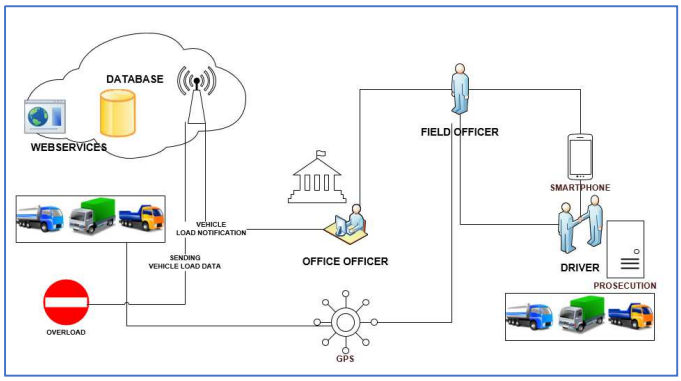


Fig. 3 E-overload Application Business Process

The vehicle is fitted with a vehicle load counter. Its function is to detect the load generated by the loaded vehicle and whether it meets the tonnage of the vehicle or not. If the tonnage of the vehicle exceeds the tonnage of the maximum vehicle limit, the load counter sensor will provide a warning on the vehicle. Alerts and alarms on tools that have been installed in the vehicle. Vehicles are fitted with a GPS location [25] tracking device, whose function is to track the location of vehicles that violate heavy tonnage on vehicles traveling on the highway. This GPS is installed in the vehicle and a vehicle load counter device, to make it easier for officers to track the vehicle and make it easier for officers to take action in the field if there are officers closest to the vehicle's location.

Officers at the office see data on vehicles that violate the tonnage. Their function is to monitor vehicles that exceed the tonnage load and record how many vehicles violate the tonnage on the highway. Officers in the field take action against drivers of vehicles that violate, and officers give a letter of action to drivers who violate excessive tonnage in the vehicle. The driver of the vehicle gets a ticket from the officer in the field, and the driver who violates it is given a warning letter to reduce the tonnage load on the vehicle

2) Needs Analysis: The device used in this study is to build an e-overload application. We divide the need for these devices into several parts, including:

• Hardware device requirements. The hardware devices needed to build this e-overload application are as follows:

1. Rasberry pi. Microcontroller
2. Weight Sensor :
   - Pressure Sensor
   - Sensor Load Call
3. Sockbecker Tubes
4. GPS Tracker.
5. Trucks made of wood
6. GSM card
7. Android Smartphone

• Software device requirements. The software tools needed to build this e-overload application are:

1. Android Studio
2. Whatsapp Bots

B. Design

At the design stage, there are several steps taken in building an e-overload application. We divide the design into several parts, including:

1) System architecture design: The first step is to determine whether the actor is the person who interacts or the person who uses the application. In this application, the actors are drivers, field officers, and office workers. Table 1 defines the tasks of each actor more clearly, which is the definition of the e-overload application.

TABLE I
DEFINITION OF ACTORS ON E-OVERLOAD

No	Actor	Description
	Driver	People who own heavy vehicles will be prosecuted in the field if they violate the laws and regulations regarding the tonnage of the vehicle they are driving.
	Officer in the field	The person on duty on the highway, the person who will take action against the driver of a heavy vehicle, violates the tonnage load of the vehicle on the highway
	Officer	People who monitor the vehicle tab on the highway through the website application

2) Use a Case diagram

- Officer use case diagram [26]. Figure 4 shows that the Transportation Agency officers carry out activities to monitor vehicles on the road, see vehicles that violate the road, look for vehicles that violate, and take action against vehicles that violate the road. DINHUB officers monitor vehicles on the highway, check vehicles that violate, and take action against vehicles that violate the highway

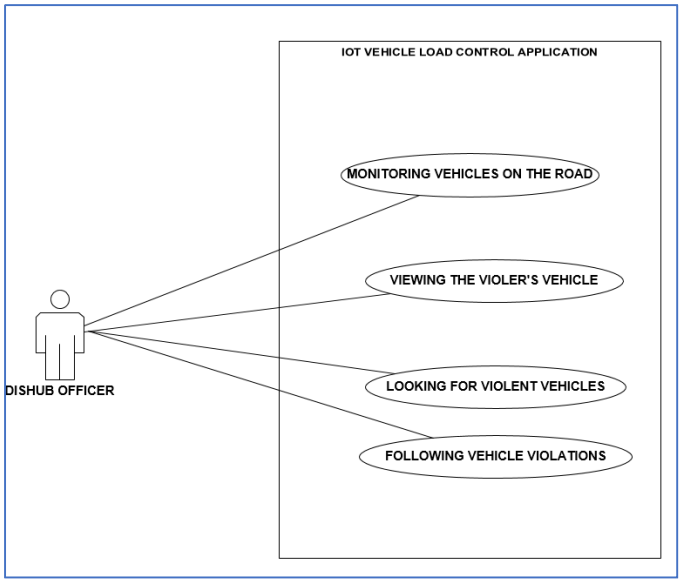


Fig. 4 Use Case Diagram of Transportation Service Officer

- Driver Use Case Diagram. Figure 5 above shows the Use Case diagram for the Vehicle Driver to check the initial vehicle load, fill the vehicle load, and check the vehicle load weight, and after completion, the cargo vehicle can walk on the highway safely.

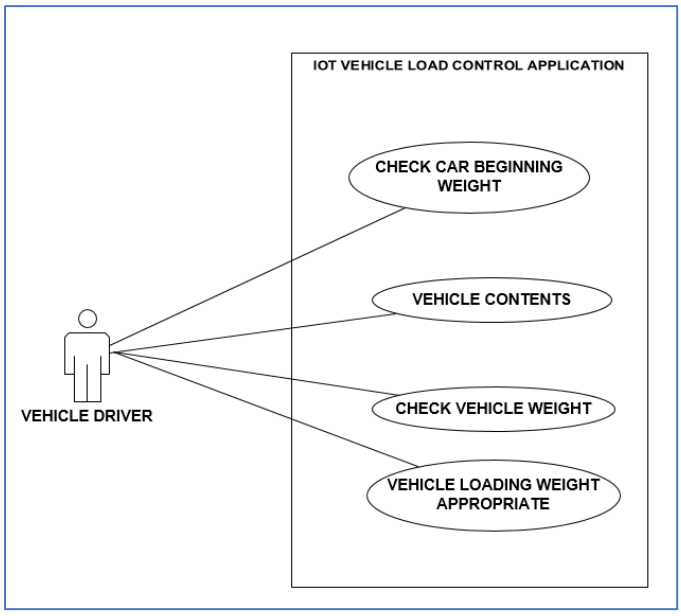


Fig. 5 Use Case Diagram Driver

3) Sequence diagram [27]: Figure 6 above shows that the e-overload application [28] system will send a signal to the DINHUB officer in the field if a driver is carrying a load exceeding capacity; after receiving a signal from the vehicle, the officer immediately looks for and takes action on vehicles that exceed the load on the highway.

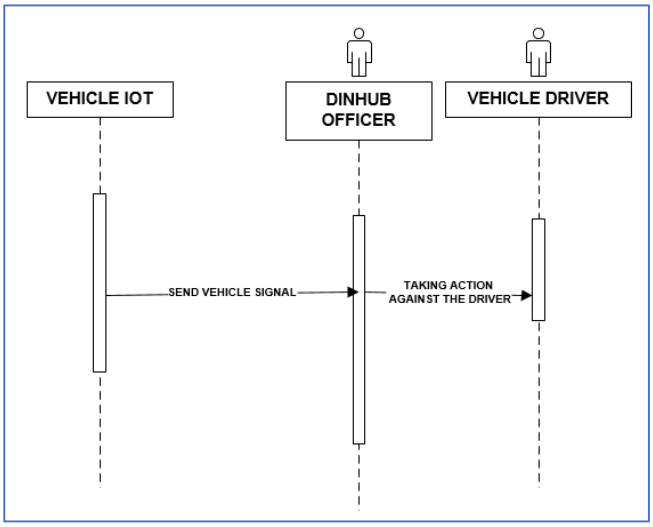


Fig. 6 Sequence Diagram of e-overload Application

4) Activity diagram [29]*:* The activity diagram [30] of the process of the e-overload application is shown in Figure 7 below:

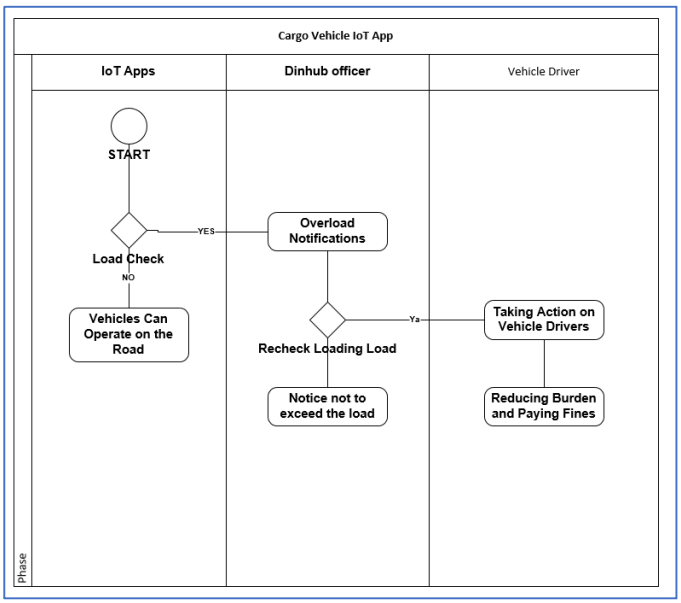


Fig. 7 Activity diagram of the e-overload application

Figure 7 shows the activities that occur in the e-overload application. The e-overload application will check the weight of the vehicle's load. If it is found that the vehicle is overweight, the system will send a notification to the officer. The officer will verify and notify the driver. If the driver adjusts the vehicle's load, the officer will permit them to continue the journey. If the driver does not adjust the vehicle's load, the driver will be given a ticket and forced to reduce the vehicle's load.

C. Program Code Writing

The program code is written to set the desired conditions on the Arduino device. The input comes from the weight sensor mounted on the vehicle. While the output is in the form of notifications and load reports for each vehicle that is

installed with an e-overload device. The programming language used is Python programming language [31]. The functions of the program code embedded in the e-overload device are:

1) Detect load capacity [32]: The device is coded to be able to take input from the load cell, and the data will be processed and compared with the specified fixed variable. So that it provides notification output to be forwarded to drivers and officers

2) *Sending the location of the vehicle:* The device is coded to convey the vehicle's coordinates in real-time to the officer.
3) *Sending infringement notifications: This d*evice is coded to be able to convey vehicle violation messages to officers and drivers. If the driver does not heed the message of violation, the officer will act and secure the vehicle

D. Testing

Prototype [33] testing was carried out at the transportation service with the team. The prototype test is carried out to determine whether the e-overload application is in line with expectations. The following is a display of the Cargo Vehicle e-overload system that has been tested. Figure 8 below is an image of a prototype vehicle made of wood that wood vehicle craftsmen sell. This vehicle is used to install and test the e-overload application, and the weight used is using the weight of the scales, namely, ounce, ounce, 1/ kg, 2kg, and 3Kg weight.

Fig. 8 E-overload display on the vehicle

Figure 8 above shows an LCD device that is installed on the body of a loaded vehicle which functions to view and monitor the initial weight and weight that the load on the vehicle has filled.

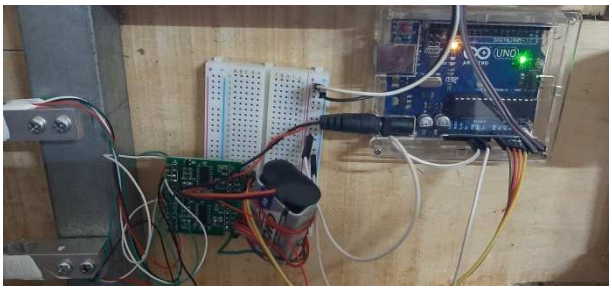


Fig. 9 Functions of the e-overload circuit

Figure 9 shows a series of e-overload prototypes installed under the deck of a loaded vehicle. The tools installed include Arduino Uno, battery, load cell, PCB, GPS, gsm, and LCD monitor.

```
void loop() {

  scale.set_scale(cal1); //sesuaikan hasil pembacaan dengan nilai kalibrasi
  scale1.set_scale(cal2); //sesuaikan hasil pembacaan dengan nilai kalibrasi

  Serial.print("Berat 1: ");
  Serial.print(scale.get_units(), 3);
  Serial.print(" kg");
  Serial.print(" calibration_factor: ");
  Serial.print(cal1);
  Serial.println();

  Serial.print("Berat 2: ");
  Serial.print(scale1.get_units(), 3);
  Serial.print(" kg");
  Serial.print(" calibration_factor: ");
  Serial.print(cal2);
  Serial.println();
```

Fig. 10 Vehicle alerts source code

In Figure 10 above, the source code generates and displays an alert if the load on the vehicle exceeds the capacity. If the vehicle carries a load above the maximum limit of the load, the sensor will light up or make a sound.

```
// pembacaan if
    if (total >3){
    //digitalWrite(RELAY,HIGH);  // Menyalakan Relay
    lcd.print("melebihi batas");//menulis kata
    Serial.print("melebihi batas");
     delay(3000);//menunggu 3000 milidetik
    lcd.clear();//menghapus tampilan LCD
   }
   else if(total <= 3){
   // digitalWrite(RELAY,LOW); // Mematikan Relay
   lcd.print("aman");//menulis kata
    Serial.print("aman");
   delay(3000);//menunggu 3000 milidetik
    lcd.clear();//menghapus tampilan LCD
   }

}
```

Fig. 11 Load limit source code on LCD

Figure 11 above shows the source code for generating the display on the LCD monitor installed on the cargo vehicle. The function is to show the load before and after the load is added to the body of the vehicle.

Fig. 12 The screen before being given a heavy load

Figure 12 shows the state of the vehicle's weight before it is filled with cargo on the vehicle, on the screen shows the weight of the empty vehicle tub that has not been filled with the cargo that will be loaded on the vehicle. Figure 13 shows the state of the vehicle's weight after being filled with a heavy load on the vehicle. The screen shows the weight of the vehicle's body that rises when the load is entered into the

vehicle's body. This shows that the load sensor and LCD layer have been successful.

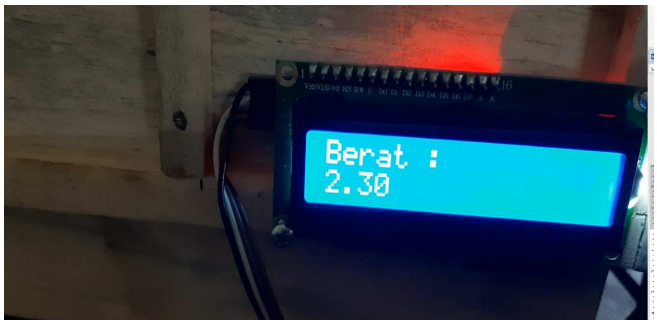


Fig. 13 Screen after being given a heavy load

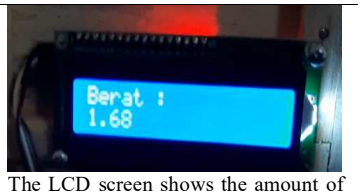
Figure 14 shows that we presented the results of the e-overload prototype to the Department of Transportation to make the prototype results feasible or not feasible to be applied in Banyumas. The Department of Transportation appreciated the Amikom University Purwokerto team for making IT breakthroughs aimed at the Banyumas Transportation Service. The prototype can be addressed directly to the Minister of Transportation from the Head of the Vehicle Section Head.

Fig. 14 Prototype Simulation at the Banyumas Transportation Service

Fig. 15 Q&A Session with the Banyumas Transportation Service [34]

Figure 15 shows a question-and-answer session between the research team and the transportation agency. The head of the IT Department of communication and information, Mr. Andiono, accompanied the question-and-answer session. Besides that, the research team expressed the advantages of this e-overload, and we hope that the relevant parties, especially the Minister of transportation, can mass-produce this tool. The contribution of this research is to assist the transportation agency in the early detection of cargo loads vehicles in real-time that can be monitored using a smartphone, and there is a GPS to monitor vehicles when they are still driving on the highway so that it can reduce the damage on the highway. The stages of testing carried out in this study used the technical testing method, namely by conducting direct testing of the prototype results that had been made and used from the beginning of testing to the end. The following is a table of the results of tests carried out on the prototypes carried out:

TABLE II
PROTOTYPE TESTING RESULTS

Initial Test Conditions	Final Result
 The initial condition of the LCD lights up indicating the tool is working as it should.	 The LCD screen shows the amount of the vehicle's load.
 When there is an additional amount of weight, the LCD screen will display the total amount. The image above shows the initial weight when the vehicle is not loaded.	 The LCD screen displays the load amount. The vehicle is filled with a load that has been given by the research team.

IV. CONCLUSION

This research resulted in an IoT Application for Cargo Vehicles. This application can help the Transportation Service Officer to take action against motorists who carry loads that exceed the minimum limit of the vehicle's load. This application is expected to prevent accidents due to brake failure caused by overload and prevent damage on the highway. This application can be applied to loaded vehicles in Indonesia to support the Ministry of Transportation or related parties in tracking all violations of vehicle overload. The feature that will be built in the next research is the mobile application feature which is intended for officers from the Department of Transportation in the field so that they can take action against motorists who violate the highway in real-time.

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