Connected Logistic Solution, Moving Asset Tracking

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***Abstract*— The problem encountered by the shipping company is the limitation in monitoring logistics vehicles in the form of motorcycles. To overcome this problem, a motorcycle monitoring system and courier driving behavior were designed. The monitoring system is divided into two aspects, namely hardware and software. Hardware is embedded in the motorcycle that serves to obtain monitoring data from the motorcycle. The software resides in the cloud that functions to store, process further, and display data. Hardware and devices are connected by a data communication infrastructure. The monitoring system is realized by being broken down into six subsystems, namely power subsystem, data acquisition subsystem, data preprocessing subsystem, communication subsystem, cloud computing subsystem, and user interface subsystem. All subsystems on the system were successfully implemented and tested successfully.**

Keywords—Monitoring, hardware, software, communication infrastructure

I. INTRODUCTION

Currently, buying and selling online is a common thing done by the people of Indonesia. There are various aspects that support this process, one of which is the process of shipping goods. The process of sending goods is responsible for the punctuality of delivery and also the condition of the goods sent.

In the delivery of goods, various problems were encountered, among others the cost of shipping goods increased due to high fuel consumption, the cost of labor involved in the delivery of goods increased, communication between consumers and supply suppliers was still not open. Some companies encountered problems such as embezzlement of goods by couriers [1], goods didn't arrive on time [2], goods arrived in bad condition [3], lack of monitoring related to the location of goods, and lack of vehicle security from theft [4]. One of the roots of the problems mentioned is the lack of monitoring of courier motorbikes to deliver goods. Lack of monitoring of courier delivery vehicles results in less accurate scheduling, difficulty detecting delays and bottlenecks, increased risk of lost goods, less efficient routes taken by couriers, and jeopardizing the security of vehicle assets.

Based on the explanation that has been mentioned above, the problem that exists is the company's limitations in monitoring logistics vehicles in the form of motorbikes and courier driving behavior in the process of delivering goods. Therefore a system that allows companies to monitor vehicles and courier driving behavior is needed.

The problems presented will be solved by vehicle monitoring systems and courier driving behavior through IoT-based products. This product consists of three main components, namely hardware that functions to acquire monitoring data from motorcycles, communication infrastructure that functions to regulate the flow of data from motorcycles to be stored in a database, and an interface system that functions to display monitoring data to users.

The hardware is realized by using various sensors, modules, microcontrollers, and also power circuits. Sensors and modules function to obtain, store and transmit monitoring data. Microcontroller to process all data collected by sensors and modules. The hardware power is regulated by power circuit.

The communication infrastructure consists of communication modules on motorcycles, brokers, and databases. The communication module serves to transmit all monitoring data that has been processed by the motorcycle. The broker serves to receive data from the communication module. The data is then entered into the database through a javascript program

The system interface serves to display the data stored in the database to the user. In addition, the interface system displays analysis data from cloud computing to display an assessment of driving behavior as well as other observation functions such as geofencing, as well as historical routing.

In this article, we will discuss how to realize a vehicle monitoring system product and courier driving behavior. This article is composed of five chapters. Chapter I discusses the background of the problem and the products to solve the problem. Chapter II discusses the features and specifications of the product to solve the problem. Chapter III discusses the design of the product in the form of a vehicle monitoring system and courier driving behavior. Chapter IV discusses the implementation and testing of the monitoring system. Chapter V discusses the conclusions from the results of the realization of the monitoring system.

II. FEATURES AND SPECIFICATION

A. Systems Feature

The features of the monitoring system are made to solve the problems encountered by shipping companies. The following are the features that want to be realized:

1. Main Feature
   Can monitor the movement of logistics vehicles for shipping goods in the form of motorbikes with regular data retrieval and securely store data on the server.
2. Basic Feature
   - Can track vehicle location and speed
   - Can identify courier ID
   - Can monitor courier driving behaviorDapat mendeteksi pencurian kendaraan
   - Can monitor information from multiple vehicles at once
   - Can record trip data from the vehicle
   - Can monitor the battery and fuel level of the vehicle
3. Additional Feature
   - Can assess courier behavior in driving
   - Data can be seen by user remotely
4. Expected Nature of Solution
   - Easy to use by users with non-technical backgrounds
   - Software on the product can be updated
   - Infrequent Maintanance

B. System Specifications

The specifications of the system are derived from the features that are expected to be realized in the product. The following are the specifications of the system:

TABLE 1. PRODUCT SPECIFICATIONS

No	Specification	Detail
1	Product Dimension	Maximal dimension: (18 ± 0,2) cm x (8 ± 0,2) cm x (5 ± 0,2) cm
2	Product durability	IP67 Compliant
3	Number of vehicles that can monitored	Monitoring of a minimum of 45 vehicles
4	Operation Range	Minimum Operation Range = 14.6 km
5	Location	Error < 10 m
6	Velocity	Range: 0 - 90 km/hour
7	Acceleration	Range: -2 -. 2m/s^2
8	Data Transmission	Data transmission interval every 5 minutes
9	Internal Data Storage	Stores monitoring data for 9 hours
10	Data Centre Storage	Data storage on the server is not full at least after 30 days
11	Power	Operates at 5 V (± 5%). The battery can last for 15 hours.
12	User Interface	The user interface delay is a maximum of 10 seconds and 9 out of 10 people have no trouble using the UI
13	Motorcycle fuel measurement	Can measure fuel with a range of 0-5 liters

III. CONNECTED LOGISTIC SOLUTION – MOVING ASSET TRACKING DESIGN

A. DFD (Data Flow Diagram) *System*

Level 0 DFD system represents the input and output of the monitoring system that we designed. The following is the level 0 DFD:

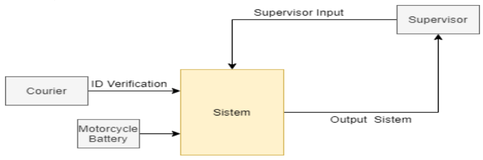


Fig 1. Level 0 DFD System

In the diagram above, the system inputs are:

- Courier ID
- Add and change courier profile

Meanwhile the system outputs are:

- Vehicle Location
- Courier Driving Behavior
- Vehicle History Routing
- Fuel Level and Motorcycle Battery Level
- Backup Battery Level

DFD level 1 system represents the interaction between subsystems in the monitoring system. In our system there are six subsystems. The following are the subsystems and their functions :

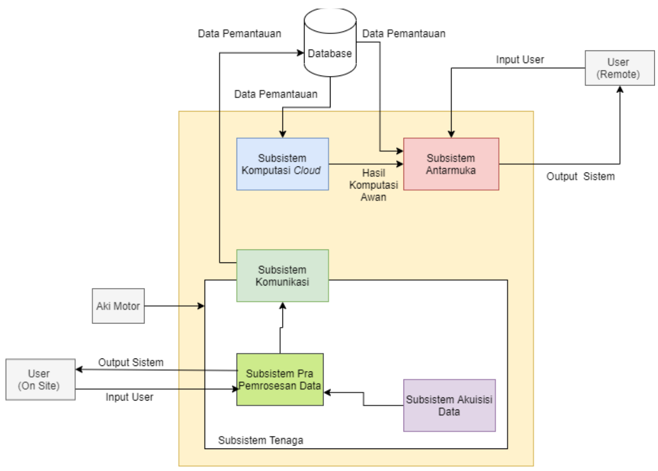


Fig. 2. Level 1 DFD System

1. Power Subsystem

   Serves to provide power to the hardware installed in the motorcycle. The power subsystem serves for interfacing between the battery and hardware. In addition, the power subsystem consists of a switching circuit between the hardware battery and the motor battery and also for connecting the hardware battery and the motor battery when the battery is running out of power.

2. Data Acquisition Subsystem

   Serves to retrieve monitoring data from motorcycles. The data acquisition subsystem consists of sensors, modules, and also wiring to the internal motor system to retrieve battery level, fuel level, and ignition status information. In addition to the data acquisition subsystem, it consists of an ADC which functions to change analog data from a motorcycle so that it can be read by the microcontroller.

3. Data Pre-Processing Subsystem

   Serves to process data obtained from the data acquisition subsystem. Another function of this subsystem is to validate the identity of the courier. This subsystem will prevent the vehicle from starting if the courier has not been successfully verified. The pre-processing data subsystem consists of a microcontroller as a data processing center on the hardware in the motorcycle. This microcontroller is connected to the data acquisition subsystem to obtain monitoring data.

4. Communication Subsystem

   Serves to regulate the flow of data on the system. The communication subsystem consists of a communication module and a broker. The communication module serves to transmit monitoring data processed by the data pre-processing subsystem to the broker [5]. The broker serves to save data to the database [6]. Brokers and databases stored on AWS EC2 via containerization and docker.

5. Cloud Computation Subsystem

   Serves to process data stored from the database. The cloud computing subsystem functions for geofencing and the process of limiting the movement of couriers. Another function of this subsystem is to get values from courier driving behavior, security status of courier vehicles, and historical routing. This subsystem is realized on the ThingWorx IoT platform.

6. User Interface Subsystem

   Serves to display monitoring data to users. This subsystem is realized on the ThingWorx IoT platform.

B. Power Subsytem Design

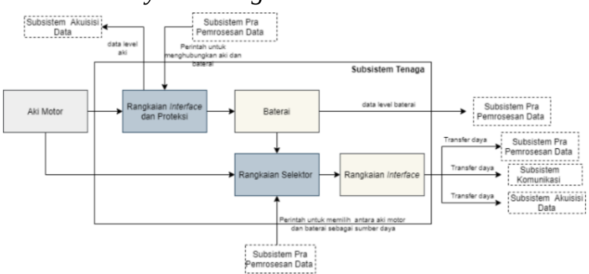


Fig. 3. Power Subsystem Level 2 DFD

The power subsystem consists of five components, namely motorcycle battery, interface and protection circuit, battery, selector circuit, and interface circuit. The motor battery serves as the main power source of the hardware. Interface and protection circuit to recharge the battery when the battery level is low. The selector circuit is used to select the resources used by the hardware. There are two power source options, namely back up battery and motorcycle battery. The motor battery is the main power source of the hardware, when the motor battery voltage begins to drop, the main source is replaced by a back up battery by the selector circuit. The interface circuit serves to interface the power source as well as the battery and motor battery to other subsystems in the hardware.

In the power subsystem, data on battery voltage level and battery voltage level are taken. These two data will be used by the data preprocessing subsystem to determine the behavior of the selector set and also to send both data to be stored in the database and displayed to the user.

C. Data Acquisition Subsystem Design

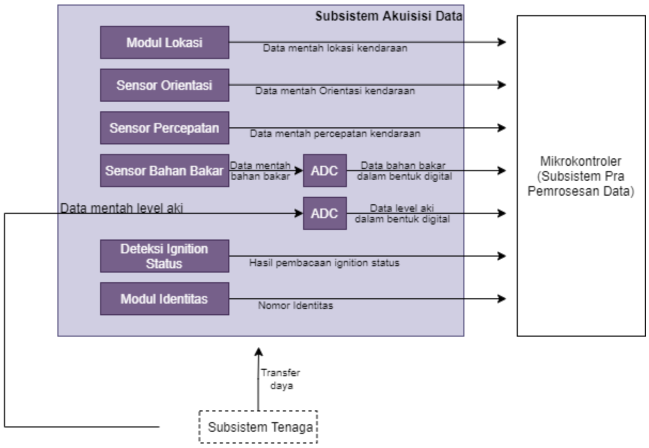


Fig. 4. Data Acquisition Subsystem Level 2 DFD

The data acquisition subsystem consists of sensors and modules. Sensors and modules function to obtain monitoring raw data. In addition, this subsystem consists of wiring to the motor electricity to obtain raw data on battery level, fuel, and ignition status. The ADC is used to retrieve analog data from the motorcycle so that it can be read by the microcontroller. All data obtained in this subsystem will be further processed in the data pre-processing subsystem.

D. Data Pre-processing Subsystem Design

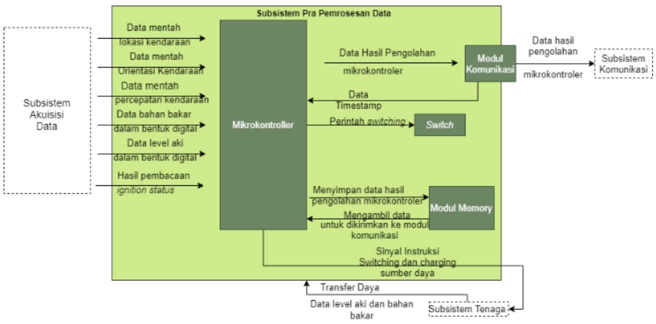


Fig. 5. DFD Level 2 Subsistem Pra Pemrosesan Data

The data pre-processing subsystem consists of five components, which are communication module, identity module, memory module, switch, and microcontroller. The microcontroller serves to process the raw data received from the data acquisition subsystem. Then the data results are processed and stored temporarily in the memory module. In addition, the microcontroller also sends a switching command to the ignition switch when the results sent by the reading in the identity module are in accordance with those stored in the microcontroller. Another command sent by the microcontroller is the command to connect the battery and battery to recharge the battery.

The memory module serves to temporarily store the data from the microcontroller processing. The data from the microcontroller processing will not be sent directly but stored for a certain time, depending on the state of the motor is idle or active. When a certain time elapses, the data will be sent by the communication module. if the sending process is successful then the data will be deleted from the memory module. However, if the data is not successfully sent, the data will be stored first until the next delivery cycle and the recent data is successfully sent.

E. Communication Subsystem Design

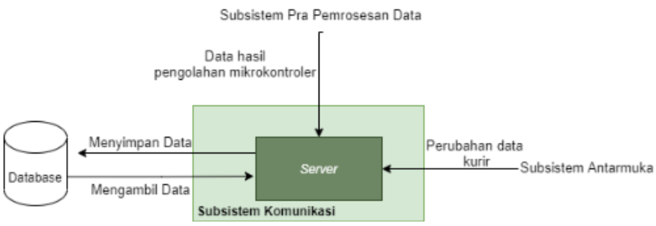


Fig. 6. DFD Level 2 Communication Subsystem

The communication subsystem consists of a server and communication modules. This server serves to carry processed data sent by the communication module and profile changes from the interface subsystem to be stored in the database. This server is asynchronous in order to streamline the cellular communication network that is used to transmit monitoring data from motorcycles. Thus, the communication module cannot save data to the database direcetly.

F. Cloud Computing Subsystem Design

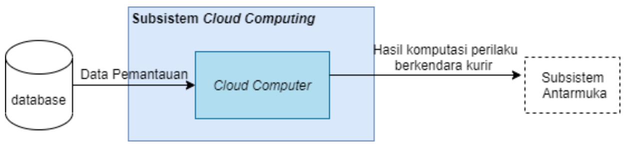


Fig. 6. DFD Level 2 Cloud Computing Subsystem

The cloud computing subsystem consists of cloud computers. Cloud computers function to process data stored from databases. The cloud computers perform geofencing to limit the movement of couriers so that they do not exceed their operating areas, analyzing courier's driving behavior and courier's driving safety status, and compiling historical routing of a courier. Cloud computers are implemented using the ThingWorx IoT platform.

G. User Interface Subsystem Design

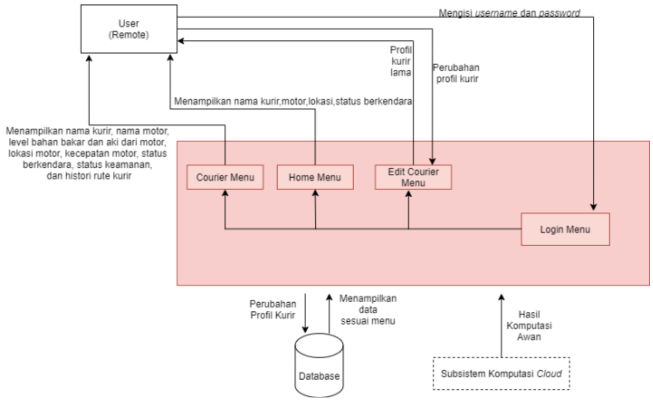


Fig. 7. DFD Level 2 User Interface Subsystem

The interface subsystem serves to display information to the user. In the interface subsystem there are 3 pages, which are Login Menu, Home Menu, Courier Menu, and Edit Courier Menu. The login page serves to verify who can access the monitoring data. The login page will ask for a username and password. Then when the verification is successful. It will enter the home menu. In the home menu there is a brief monitoring information of all couriers on the system. Then from the home menu, the user has the option to stay on the home menu or move to the courier menu and edit the courier menu. If the user enters the courier menu, the complete information of a courier will be displayed. If the user enters the edit menu of the courier, the user can change the profile of the courier.

IV. Implementation and Testing of Connected Logistic Solution – Moving Asset Tracking

A. Implementation of Power Subsystem

To be able to perform the features of the power subsystem, it takes several circuits that have previously been simulated. In this implementation, there are several circuits that can realize these features. To understand the workings of this power subsystem better, the image below shows the circuit of power subsystem.

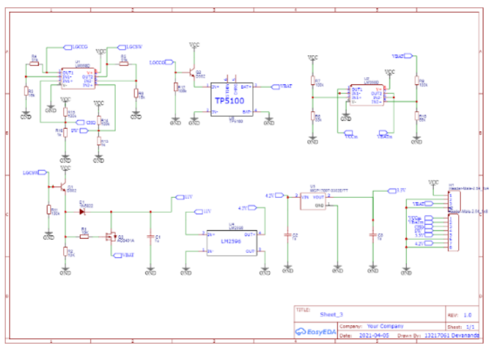


Fig. 8. Schematic of Power Subsystem

In this schematic there are 6 parts of the electrical circuit that have their own functions. This circuit consists of a logic converter, a switch and charging circuit, a main switch, a buck converter, a sensing circuit, and a linear voltage drop regulator. The power switching process can be done with MOSFET and BJT[7]. Each of these parts has a function to realize the various features previously mentioned. The realization of this circuit is shown on image below.

Fig. 9. PCB of Power Subsystem

B. *Implementation of Data Acquisition Subsystem*

The data acquisition subsystem is realized by using sensors, modules, and wiring to the motorcycle to acquire ignition data, fuel level, and battery level. The following are the sensors and modules used:

- GPS Module BN-280 to acquire location
- IMU GY85 which consists of accelerometer ADXL345 dan Gyro ITG3205 to acquire acceleration and gyro reading.
- Fuel level, battery voltage, and ignition status are obtained by connecting the electricity on the motorcycle to the interface circuit of the microcontroller's ADC.
- Driver's information is acquired RFID module MFRC522

C. *Schematic of Data Acquisition and Data Pre-processing Subsystem*

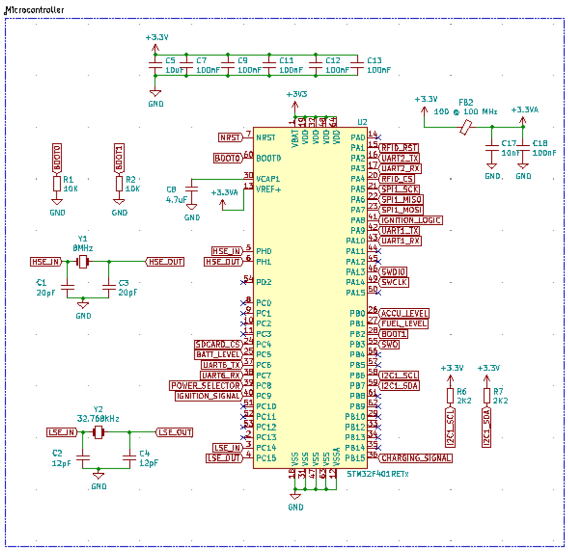


Fig. 10. Schematic of Data Acquisition and Data Preprocessing Subsystem - Microcontroller

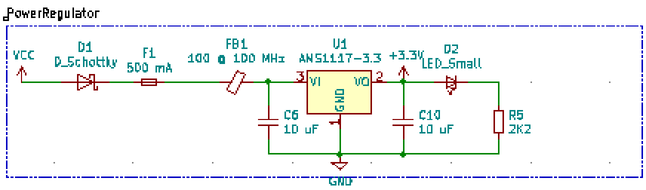


Fig. 11. Schematic of Data Acquisition and Data Preprocessing Subsystem – Power Regulator

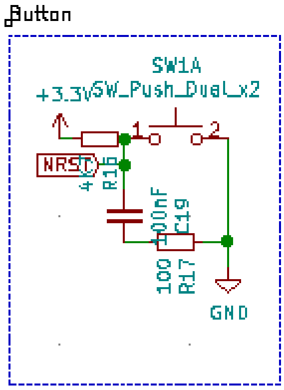


Fig. 12. Schematic of Data Acquisition and Data Preprocessing Subsystem–Reset Button

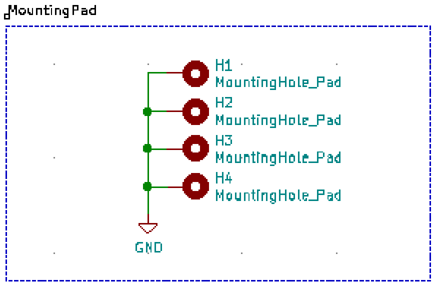


Fig. 13 . Schematic of Data Acquisition and Data Preprocessing Subsystem – Mounting Pad

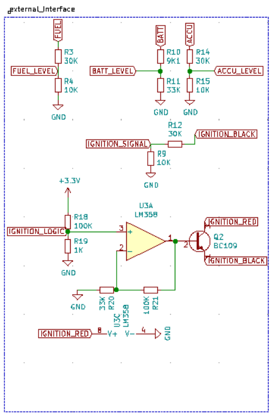


Fig. 14. Schematic of Data Acquisition and Data Preprocessing Subsystem –Interface Circuit

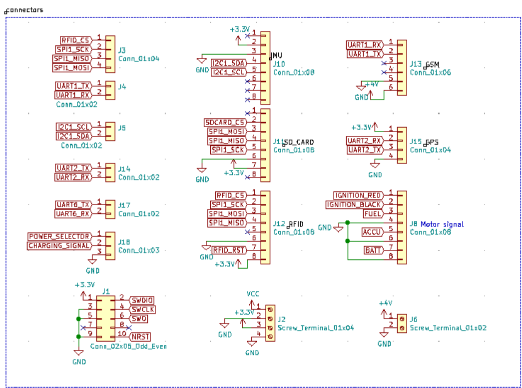


Fig. 15. Schematic of Data Acquisition and Data Preprocessing Subsystem - Connector

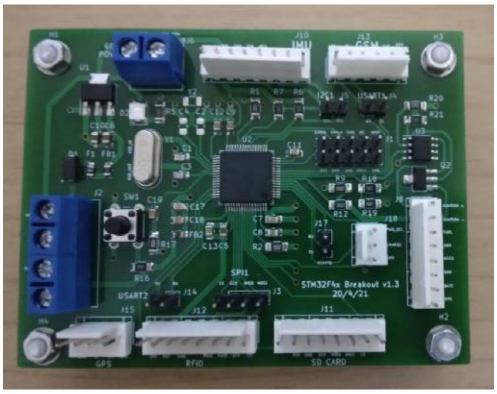


Fig. 16. PCB of Data Acquisition and Data Preprocessing Subsystem

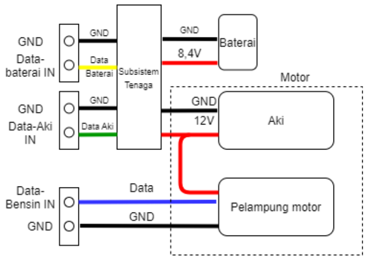


Fig. 17 Wiring between Motorcycle and the device

D. *Implementation of Data Pre-processing Subsystem*

The data pre-processing subsystem is realized by using modules and microcontrollers. The following are the modules and microcontrollers used:

- SIM A9G as communication module
- Robotdyn SD Card Module as SD Card Module
- RFID Module Reader/Writer as Identification Module
- STM32F401RCT6 as microcontroller

In this subsystem, the data obtained from the data acquisition subsystem is processed. The data processing carried out is:

1. Calculation of vehicle speed

Speed calculation is done by moving the vehicle's position based on location data from GPS. The distance of the vehicle position is calculated using the law of the cosine of the sphere. The equation used to calculate the law of spherical cosine is:

$$d = R \cdot \text{acos}\,(sin\ \varphi_1 \cdot sin\ \varphi_2 + cos\varphi_1 \cdot cos\varphi_2 \cdot cos\Delta\lambda)$$

where:

$$\varphi : Latitude$$

$$\lambda : longitude$$

$$R : Earth\ Radius$$

After obtaining the distance, the average speed can be calculated over the time lapse. The time lapse taken is the time it takes the GPS to acquire a new position.

2. Calculation of Average Acceleration, Maximum Acceleration, Average Speed and Maximum Speed

The calculation of maximum acceleration and maximum speed, used a simple maximum value search algorithm. First, the maximum value is assigned the lowest value, which is zero. Then if the new data is greater than the current maximum value, the new data becomes the latest maximum value. The maximum value will be reset back to zero after the data recording period is over.

Calculation of the average acceleration and average speed using a simple mathematical calculation as follows:

$$avg = \frac{1}{N}\sum_{i=0}^{N} a_i$$

3. Paylod and Data Recording

Processed data needs to be 'packaged' before it can be sent. In this product design, data is recorded every 10 seconds. Recorded data include:

- Latitude
- Longitude
- Percepatan rata-rata kendaraan
- Percepatan maksimum kendaraan
- Giro maksimum motor
- Kelajuan rata-rata kendaraan
- Kelajuan maksimum kendaraan
- Tingkat bahan bakar
- Tingkat tegangan aki
- Tingkat tegangan baterai
- *Ignition status*

Each time data recording is performed, the time data (timestamp) is obtained from the communication module. For each payload, there are two data recording packets packaged in JSON format. Every 20 seconds, the payload can be sent to the server.

After one payload has been completed, the payload will be sent through the communication module contained in the communication subsystem. If data transmission to the server is not successful, the payload will be stored on the SD Card using the SD Card module.

4. Power Source Switching Signal, Charging Signal, and Ignition Switch Signal Control

The power source switching signal and the charging signal are controlled based on the readings of accu voltage, battery voltage, and ignition status from the data acquisition subsystem. By default, the product draws power from the accu, but if the accu is in poor condition or the motor is on, the power will switch to the battery. The battery will be charged to the battery when the voltage is below 6.8 V and will finish charging when the voltage is 8.4 V. The battery charging process is only carried out while the vehicle is running, which is indicated by the ignition switch on.

To control the ignition switch, an interface circuit is created as shown on image below.

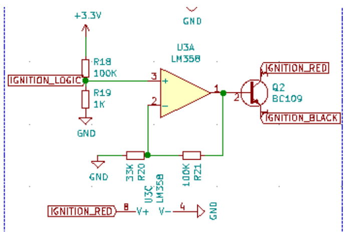


Fig. 18 Schematic of Ignition Switch Control Circuit

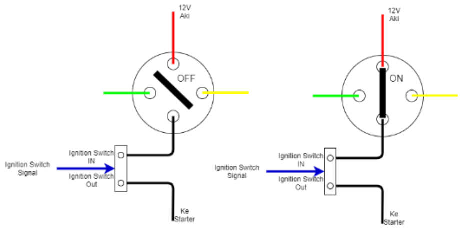


Fig. 19 Wiring between Ignition Switch and device

The circuit consists of an LM358 amplifier and a SOD82688 BJT transistor. When the Ignition Switch is in the ON position, the black wire will be connected to the 12V accu. When the IGNITON_LOGIC signal is HIGH then the booster output will produce a voltage of 12V. The output of the amplifier biases the BJT transistor and causes current to flow from collector to emitter. When the IGNITION_LOGIC signal is LOW then the output will be 0 V so current cannot flow from collector to emitter.

The IGNITION_LOGIC signal will be HIGH if the device is successful in verifying the driver's RFID card and LOW if the card is not successfully verified.

E. *Implementation of Communication Subsystem*

The realization of the communication subsystem can be seen from the following scheme:

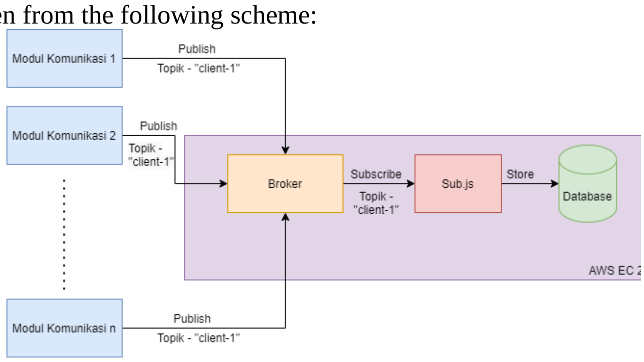


Fig. 20. Communication Subsystem Scheme

In the application of data communication infrastructure there are three main components, namely communication modules, brokers, and databases. Communication modules are placed on each motor whose activities and locations want to be monitored. The communication module sends monitoring data over a 2G mobile network. Communication module delivery is delivered when two sets of monitoring data have been collected. The reason for sending two sets of monitoring data, due to the limitations of the communication module is the A9G SIM module. The A9G SIM module can only transmit 444 bytes of data.

When sending data, there is data from which the data is sent. The data is stored in JSON. This data determines in which table the monitoring data will be stored, as the data on one courier will be stored in a table named "db1". The broker used is Mosquitto. The broker is tasked to receive data from the communication module, the data will then be forwarded to subs.js. Subs,js is tasked to receive data from the broker and save it to the *database.* Subs.js realized with javascript language make use of mqtt *library* to be able to connect to broker, voca *library* for formatting data received from communication module, and pg *library* to save data to PostgreSQL database.

Brokers and *databases* are deployed on AWS EC2 with the following *deployment* schemes:

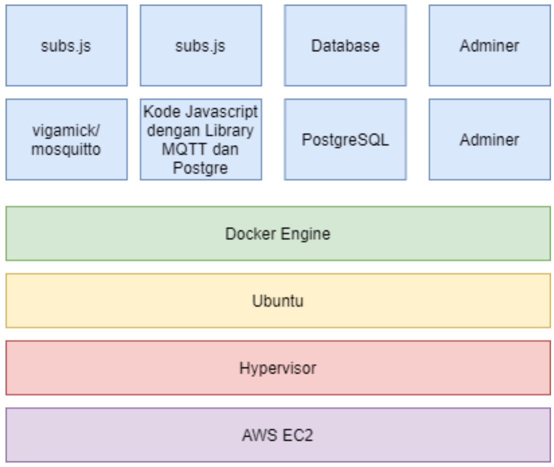


Fig. 22 BrokerAnd Database Deployment Scheme

The schema of *the deployment* in the cloud [] is by containerization. The server used as a cloud in our system is AWS EC2, which is installed ubuntu operating system. In ubuntu installed Docker Engine which serves to do containerization. There are four containers that will be installed by Docker Engine, the first is the data storage system by subscribers which is javascript code, the second is a database that serves to store all monitoring data from the system, the third is mosquito that serves as a broker in the communication infrastructure of the monitoring system, the fourth is the adminer that serves to organize the database. The adminer makes it easy to view the data stored in the *database*. In addition, the adminer can also create tables in the *database*, insert and delete data from the table.

F. *Implementation of Cloud Computing Subsystem*

The implementation of the data analysis subsystem is done by creating a code on the entity that becomes the template. Later this code will be passed to the entity thing that represents the data. The following is the basis of classification used to realize the three features, namely geofencing, scoring, and thief detection.

TABLE 2. FEATURES AND CLASSIFICATION OF DATA ANALYST SUBSYSTEMS

No.	feature	Classification
1	*Geofencing*	Classification of distance from Bandung city center with a radius of 14.6 km
2	Driver Behavior Assessment	Speed < 50 km/h, Acceleration between -1< x <1 m/s^2, angular speed -10< x< 10 deg/second
3	*Thief Detection*	The distance of the vehicle moving during stationary conditions is 12 m and the maximum moving speed is 6.5 km/h

Based on the table above, javascript-based programming is then carried out to realize this subsystem.

G. *Interface Subsystem Implementation*

To be able to realize the seven features previously used a little change of model from the design process so that a model such as this is produced.

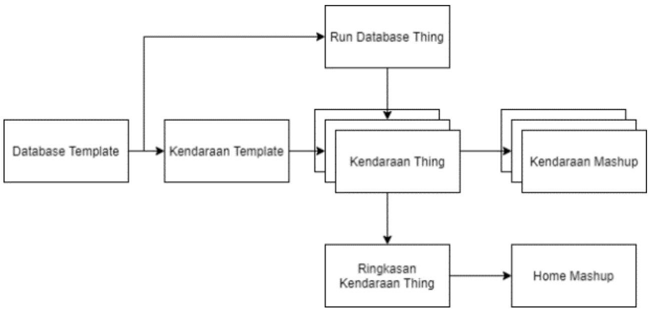


Fig. 23. Interface Subsystem Entity Diagram

Basically, the implementation model above is utilizing a number of templates that have certain characteristics to make it easier to pass data from the database to the mashup view. To retrieve data from a database, use the features of a database template that is capable of processing query data. Then the entire data will be stored on the runDatabase Thing.

Then all data from the runDatabase thing will be retrieved by each thing vehicle that will represent the assets of the vehicle. Vehicle information will be temporarily stored appropriately on properties. Important information from the vehicle that will be displayed on the home menu will be stored in the vehicle thing summary.

When the data is ready in each thing, then the next step is to create a mashup. In the mashup, a number of widgets are displayed that become a means to display data. Once the widget is set its location it is necessary to set the data binding so that the right data can be displayed to the user.

Based on the model above, the following is a mashup or final view of the home page that becomes the main target of user supervision.

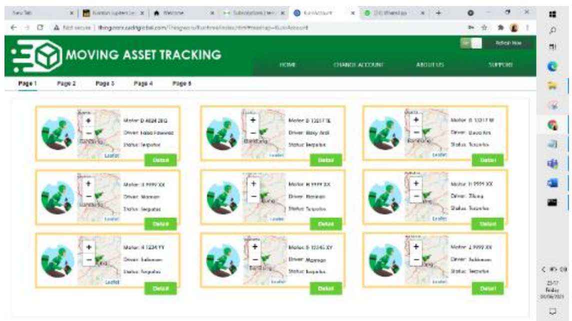
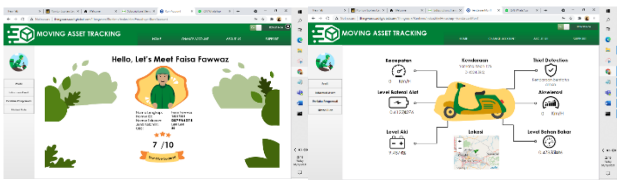


Fig. 24. Home page of the Interface Subsystem

As for the following view is a mashup for each driver that brings up information related to profiles, assets, driver behavior, and historical routes.



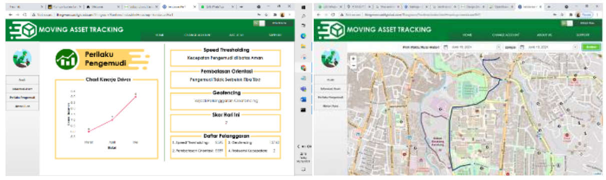


Fig. 25. Courier Page - Profile on Interface Subsystem, Information Asset on Interface Subsystem, Driver Behavior on Interface Subsystem, Route History on Specification Testing Subsystem

After the product is implemented and tested on each subsystem, the system is integrated and tested to the specifications mentioned. The following are the results of system testing on each specific mentioned:

1. Dimension

TABLE 3. TESTING OF DIMENSION SPECIFICATIONS

Specifications	Maximum dimension: (18 ± 0.2) cm x (8 ± 0.2) cm x (5 ± 0.2) cm
realization	16.4 cm x 8.2 cm x 5 cm

2. Product Durability

TABLE 4. PRODUCT DURABILITY SPECIFICATION TESTING

Specifications	Has IP characteristics 67
realization	Has IP 56 characteristics

3. Number of Monitorable Vehicles that Can Monitored

TABLE 5. TESTING OF VEHICLE NUMBER SPECIFICATIONS

Specifications	The product can monitor at least 45 vehicles
realization	The product can receive and display data sent from 45 javascript programs

4. Operation Range

TABLE 6. LOCATION RANGE SPECIFICATION TESTING

Specifications	Operating range of at least ≥ 14.6 km
realization	The product can display monitoring data from a distance of 16 km

5. Location

TABLE 7. LOCATION SPECIFICATION TESTING

Specifications	Error < 10 m
realization	Average error: 7.57 m Median error: 7 m Maximum error: 12 m Minimum error: 3 m

6. Velocity

TABLE 8. SPEED SPECIFICATION TESTING

Specifications	Range: 0 to 90 km/h
realization	Range: 0 to 128.68 km/h

7. Acceleration

TABLE 9. ACCELERATION SPECIFICATION TESTING

Specifications	Range: -2 to 2 m/s^2
realization	Range: -4 to 4 m/s^2

8. Data Transmission

TABLE 10. TESTING OF DATA TRANSMISSION SPECIFICATIONS

Specifications	Data transmission interval every 5 minutes
realization	Data transmission interval: Average :19.95 seconds Median: 21 seconds Minimum: 11 seconds Maximum: 22 seconds

9. Internal Data Storage

TABLE 11. INTERNAL DATA STORAGE SPECIFICATION TESTING

Specifications	Store monitoring data from a motorcycle for 9 hours
realization	Internal storage capacity: 64 GB Data for 1 hour: 49.43 KB Data for 9 hours: 444.87 KB Data for 24 hours: 1,186 MB

10. Data Centre Storage

TABLE 12. TESTING OF CENTRAL DATA SPECIFICATIONS

Specifications	Can store data for a month
realization	*The database* can store data for a month (259200 x 45). One month data size: 1,664 GB Database capacity: 20 GB

11. Power

TABLE 13. RESOURCE SPECIFICATION TESTING

Specifications	Operates at a voltage of 12 V (± 5%). The battery can last for 15 hours
realization	Can operate at a voltage of 12 V (± 5%). Can last approximately 33 hours

12. User Interface

TABLE 14. TESTING OF USER INTERFACE SPECIFICATIONS

Specifications	Delay *user interface* maximum 10 [11] seconds. 9 out of 10 people have no trouble using the *user interface*
realization	Delay Average: 8.911 seconds Median: 8.309 seconds Minimum: 2.311 seconds Maximum: 21.303 seconds Conducted a survey on 42 respondents. 38% answered easy to use and 62% answered very easy to use

13. Motor Fuel Measurement

TABLE 15. TESTING OF MOTOR FUEL MEASUREMENT SPECIFICATIONS

Specifications	Measuring fuel with a range *of* 0 – 5 liters
realization	Measurement range: 0 – 3.7 liters

V. CONCLUSION

Nowadays, online buying and selling transactions are a common activity conducted by the people of Indonesia. In this activity the expedition company is an integral component in the realization of a convenient transaction process. But in the implementation of the exhibition company experienced limitations in monitoring logistic vehicles and also courier driving behavior. The system we designed aims to overcome the limitations encountered by the exhibition company.

The monitoring system is broken down into six subsystems, namely the power subsystem, the data acquisition subsystem, the data preprocessing subsystem, the communication subsystem, the cloud computing subsystem, and the interface subsystem.

The power subsystem serves to supply power to the hardware embedded in the motorcycle. Power subsystem is implemented with a PCB that has the capability to interfacing hardware with motorcycle batteries and also batteries. In addition, the power subsystem also serves to switch for the power source from the motor battery to the battery if the motor battery is not sufficient.

The data acquisition subsystem serves to obtain monitoring data from motorcycles. This subsystem is implemented using various modules, sensors, and also wiring to motorcycles.

The pre-processing subsystem serves as a data processing center on motorcycles. This subsystem processes data obtained from the data acquisition subsystem into data that can be understood by humans. In addition, this subsystem also provides switching signals on the power subsystem and switching on ignition if the profile of the courier has been successfully carried out.

The communication subsystem serves to regulate the flow of data from hardware and software. This subsystem is implemented using communication modules, brokers, and subscriber programs. The communication module is embedded in the motorcycle, while brokers and subscribers are in the cloud. The broker serves to receive data from the communication module and forward it to subscribers. The role of subscribers is to save monitoring data from motorcycles to the database.

The cloud computing subsystem serves to process the monitoring data stored on the database into courier behavior data in driving. The temporary subsystem interface serves to display monitoring data to product users. Cloud computing subsystems and interfaces are implemented on the ThingWorx IoT platform.

Once the system is implemented, it is necessary to test the specifications that have been set. Based on 13 specifications, the system we have created meets 11 predetermined specifications.

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