BUSINESS DURING COVID: AN IOT (INTERNET OF THINGS) BASED AUTOMATED SAND TRUCK MANAGEMENT SOLUTION

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ABSTRACT

As a result of the development in computing technologies have begun to believe the human expectations on these needs in the different sort of components. The eSand Transport System with IOT (eSTSI) is a sand transport system designed to provide secure and accurate data such as gross weight with the sand and the truck, viewing the details of the owner when the RFID card is detected, sending alerts through the mobile application from the Firebase by interconnecting with the IOT device, viewing the schedule of the selected truck with the date and destination, and displaying the location once the truck is passed the checkpoint. The main functionalities of eSTSI are to identify the truck with the correct information via the RFID card that retrieves the data who has enrolled with the app and stores the data in the firebase. The expected services are aimed to provide by this system.

KEYWORDS

RFID, IOT, Mobile Application, Firebase, Vehicle, recognition, system, public

1. INTRODUCTION

Now days in Sri Lanka, every process is connected with the latest technologies but there are some systems which has been processed with manual. The process of transporting sand through the large-scale trucks is the one of the manual systems that has continued with manually. By the faster development from the field of vehicle number plate recognition and the availability which appears on different sectors, the data security compartment is considered as the most attention for the systems by the majority of the people. Amidst the truck identification methods, RFID vehicle recognition is the known as the most effective and the efficient one since the RFID vehicle recognition is the main source to identify the vehicle with the exactly efficient details. Although other methods such as QR code scanning and number plate reader using Open CV, are able to provide the better performances. But the above mentioned two methods are not appropriate for giving the faster and secure data for the smart interaction because of the RFID is the main method which has used in now days. The most and the entire processes which relates to the vehicle identification using RFID and the current gross weight measuring using the load cell (LC) that

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appears below the ground level at the moment. When the truck reach to the RFID sensor which locates near to the checkpoint, then the police officers who has authorized to check whether the RFID card detects the alerts when the trucks' passing the checkpoint and these two methods are the essential parts of the context for their human resources management process and the truck management process. These contexts are helped to the management such as GSMB and the police officers to take decisions which increase capability of the performances, effectiveness, and secure level of the organization like eSTSI. By the other part, to improve the effective, accurate and the speed level are the significant of detecting and identifying the performances of the sand trucks inside this organization.

2. LITERATURE REVIEW

[1] Information management for students and courses is critical since it is the cornerstone of a strong educational process. If this process is performed manually, there will be significant difficulties in dealing with many students, teachers, and classes. To update class information or make scheduling adjustments, you must put in a lot of effort. We require a software solution that allows us to access and manage such information in order to provide quick access to it. We can build it as a stand-alone client-server application, but then we must deal with issues like database server management, client upgrades, software incompatibility, and lack of support for different client platforms - this solution is only for college administration. The most effective way to deliver such a system would be to employ a cloud solution as a platform and client-side web access to this system. This strategy would free us from the need to set up our own data centre and give every user simple access to the system's resources via a web browser.Teachers, pupils, parents, and college administration.[2] IoT (Internet of Things) Based RFID Attendance System using Arduino Node MCU ESP8266 Arduino & Adafruit.io Platform using the MQTT broker. As a result, we shall employ RFID MFRC522, Arduino Nano, and Node MCU ESP-12E Board. The Arduino and RFID scanner scans RFID cards and logs the results to the Adafruit IO cloud platform using the ESP8266 Wi-Fi module. This information is shown on the Adafruit IO dashboard and can be accessible by the appropriate authorities to view and analyse attendance through the internet at any time and from any location. [3] an IOT Based Weighing Scale with HX711 Module Load Cell & NodeMCU ESP8266. The load cell will be able to measure weights of up to 40KG. The HX711 Dual-Channel 24 Bit Precision A/D weight Pressure Sensor Load Cell Amplifier and ADC Module is a compact breakout board for the HX711 IC that enables you to conveniently read load cells for weight measurement. You will be able to read changes in the resistance of the load cell and calibrate it by connecting the module to your microcontroller. [4] One of the most interesting technologies is radio frequency identification (RFID). The goal of this paper is to provide an overview of RFID technology and applications. This paper provides a brief overview of RFID fundamentals, RFID tag and reader classification, frequency usage, current applications, and advantages and limits. Radio Frequency Identification (RFID) is a catch-all name for technologies that employ radio waves to identify persons or objects from several inches to hundreds of feet away. This is an Automatic identification (Auto-ID) technology that can automatically identify any object. Identification technologies include barcodes, magnetic strips, IC cards, optical character recognition (OCR), voice recognition, fingerprint recognition, and optical strips, among others. The usage of automatic data collection systems via RFID technology aids in boosting system efficiency. For identifying purposes, a tag and reader combination is utilised. An RFID tag that is affixed to a physical object has a code. The thing is now distinctive and recognisable. Then the object transmits the tag's code. Readers are given information about the thing in this way.Although RFID is not a modern technology, it is used in new ways. RFID technology is expanding quickly. Compared to traditional identification methods like barcodes, RFID has many advantages. The barcode scanner must be pointed directly at the label in order to read the barcode. It implies that the scanner or objects must be manually moved. RFID has a fast-reading speed and can operate in the presence of a barrier. When a larger

read range, quick scanning, and flexible data carrying capability are required, this technology is more effective. FID systems are gaining popularity in a variety of industries, including manufacturing, agriculture, transportation, and manufacturing. RFID applications employ a variety of frequencies, including 125 KHz, 13.56 MHz, and 860-930 MHz for passive RFID and 433MHz and 2.45GHz for active RFID. Global RFID system standardisation is a critical topic. RFID has been implemented in several ways by various manufacturers. There is no universal norm that can be applied everywhere. For various RFID applications, many standards or protocols are proposed. These specifications contain hardware physics, tag-reader air interface specifications, and reader-host specifications. [5] RFID technology has become increasingly popular as a core technology as the Internet of Things has evolved. However, there is a major issue that needs to be addressed in present RFID implementations. That is, how can the reader read more effectively? We suggest a strategy for optimising the position of passive UHF RFID tags for this challenge. First, a near-ideal testing environment has been created. The distance between the container and the antenna is then changed along a defined direction for each position of the label attached to the container. Test the read rates for each distance. Examine the read rate trend of each tag position as the distance between the antenna and the container changes. As a result of the lack of a consistent set of RFID standards and the diversity of RFID equipment, RFID systems behave differently in passive RFID applications. The applications, particularly in the organization business, are not mature. Many RFID products cannot operate under optimal settings, and operating performance has not yet achieved nominal levels. RFID applications' utility is limited by their short scan range. Only short-range applications have previously been well suited to passive inductive RFID technology. [6] This solution is immediately connected to the RFID via the excel sheet, which reduces error. Attendance management is also handled via the excel sheet, which reduces human error. This technique is frequently used because it is widely employed in all types of systems. A Liquid Crystal Display is used to display the student's name and register number who has recorded their attendance in the correct time before the hour begins. RFID-Radio Frequency Identification is a novel method of authenticating student attendance. Each student ID card has its own RFID chip. Power nit supplies the entire machine with a 2A, 5V DC supply that is needed for the microprocessor and the embedded sensors. Google Firebase and Google Spreadsheet are used to keep the student database and timetable database for each class. The block diagram demonstrates how the blocks are logically connected and how the complete system operates. The system is designed to pull the class's schedule from the database prior to the start of the session. The RTC's time domain is sent once the timetable has been picked up to determine the current period from one to eight. A 50-minute time interval separates each phase. After the hour is determined, the processor accesses the student database from the Google database. The request from the processor to the database with the correct period, time, day, and unique ID as a post request in Google API, will deliver the required data from the Google server of the student's database. The received request is saved as a dictionary to make data access as simple as feasible. The received request includes the following information: student name, register number, RFID hash value, and student details related to attendance. These details are saved in system memory for easy access and faster response. When a student approaches the RFID reader with his ID card, the RFID reader processes the unique hash number and sends it to the RP2040 microprocessor. This data is being searched in the available data previously stored in RAM, and if the student is authenticating and the student is present in the database, his name and register number are displayed in LCD, along with a notice of Present in a specific hour and a beep sound. When the electricity required to boot u is supplied, the embedded system begins. If the system is finished, the initialization will be completed. The hardware components, including the liquid crystal display, real-time clock, and radio frequency identification module, have all been initialised. If the display hardware is ready, the step-by-step initialization process is displayed as a report in LCD. The CPU activates the Wi-Fi module and looks for a valid Wi-Fi network, then automatically authenticates and connects to the network. A beep sound is produced upon successful connection. The display shows the Wireless Access Point search. The processor

then connects to the NTP server to obtain the current time from the internet. The user's preferences determine the intended NTP time zone. The processor's desired time is received, and this time is put in the RTC module for time synchronisation. The system then sends a request to the Google database server, which includes the time, calculated period, and unique class ID. If the post request is genuine, the server responds with a legitimate message. The server response provides a timetable of the day, which is expected to provide crucial information about the classes or periods present on a specific day. This information is utilised to calculate the current hour, and the RP2040 processor sends another request to the Google Sever via Wi-Fi, requesting all the student databases in the class. The server answer contains various bits of information that must be compared, including student name, register number, and unique RFID hash number. This mechanism retrieves data to and from the server via a handshake approach. When a student inserts his RFID embedded ID card into the RFID module, the process of verifying the user begins. If the ID card's unique hash number matched the database that was loaded into memory. [7] Based on cell deformation, neural networks are used to precisely simulate a precision loadcell for sensing applied force. A series of photos are captured under varied loading situations. Using well-established image processing methods, the desired geometric properties of the cell, such as deformation and dimension, are retrieved from a sequence of photos. Following training with deformation characterisation of multiple cells, the neural network can be utilised as a precision loadcell to estimate force for new images. [8] The technology used in this solution, Firebase, was upgraded from an earlier version of Google Cloud Messaging that relied on its own console to send push notifications to mobile applications by throwing their application IDs. As of right now, Google is officially using Firebase as the latest version of Google Cloud Messaging. [9] The term "home automation system" refers to a system that uses the internet of things (IOT) to remotely monitor and operate home appliances. This is a project for the Internet of Things. The ESP32 microcontroller and Firebase allow for the internet-based remote control of four relays. Manual switches can operate the relay module if there is no internet. The ESP32 will automatically connect to Wi-Fi if it is available. The internet of things enables us to control our home automation system from anywhere on the planet. It improves the standard of living in our society by reducing the usage of unnecessary or excessive human effort. IOT-based home automation is an affordable and dependable automation solution that can reduce energy consumption while also offering users ease. A backend as a service (BaaS) is Firebase. It provides developers with a variety of tools and services so they can produce high-quality apps, increase their user base, and earn money. It was developed on the technical platform of Google.

3. ESTSI SYSTEM

3.1. Description

This eSTSI project is concerned about to develop the computerized system with truck recognition IoT device and the smart mobile application to get rid from the manual system which had used to be signed the sheets when the sand trucks are passed the checkpoint. This system is aimed to provide the expectations of the users like truck owners and police officers who handle the process of sand transporting, as well as prevent their limitation due to lack of memory loosing of storing the data using physical things such as permit sheets and prevent for having large scale storage areas to store their physical permit sheets. The project domain has initiated the development of eSTSI is vehicle recognition authentication and firebase authentication for verifying the exact data with the selected RFID card which has assigned for specific sand truck. Basically, the development is carried out from concerning to provide the reliable and effective sand truck system where is has installed. This system which includes the mobile application and IoT device is capable to authenticate the users in both items. The process of authentication in mobile application is authenticated the users by using the Firebase cloud platform which users are login

or signup to the app using their emails and which users have their details enrolled in the Firestore collections. The process of authentication in the IoT device is authenticated by using the RFID technology. The authorized person like police officers is handled and controlled the entire process. Once the enrolment is done, the users are allowed to use the mobile application without having the support from any outsider. The mobile application is facilitated to edit records in the user profile, get the current location of their sand truck, add schedules using the calendar view option, add truck details etc. to the users. When the details are added, then all the data stored in separate collection of Firestore with Firebase which has cloud platform and real time database. And also, the necessary details are retrieved on the separate screens on the mobile application when clicks the specific action buttons in the application. eSTSI is not aimed only for the sand transport system but also this might be useful to relevant sectors like harbour, public transport etc. The eSTSI project has been addressed the Human Computer Interaction issues because of the most of time this mobile application will be used and accessed by the non-computer literate people. Less complexity and high user friendliness are provided to access the system without having unnecessary details.

3.2. Background and the Scope

Computerized sand truck recognition has been the rapid exploration which has been applied to many sectors such as bus transportation management system identification, control the access, monitoring the security and examine the system. Sand tuck identification is used to identify the truck within details from the RFID card that includes data in the firebase. It is the most efficient method to variety or recognize to identify the selected sand truck based on its data. Not only the RFID electronic technology but also the Load cell which physically measures the weight of the truck when it transports the sand at the moment of detecting the RFID card. The main purpose of measuring the weight of the truck is to confirm the accuracy level of the weight and the weight which includes to the firebase by the owner. Sand truck recognition using RFID is a convenience method to get the essential details once the RFIC card is read. The Firestore in Firebase is the set of collection which includes the entire details of the trucks, owners, schedules etc. The IoT devices are used the RFID technology because it is a generic condition which use the radio waves to automatically identify and verify the people or any specific object from the distance of several inches to hundreds of feet. This technology is an Automatic Identification technology by identifying the object automatically. Barcode, IC card, Magnetic Strip, OCR, voice recognition, fingerprint and Optical Strips are known as the identification technology. Active and passive are the classification of the RFID tags. RFID technology is used to capture the data automatically which helps to extend the system efficiency and it has the high reading speed. By that reason, the time wasting is covered when the truck arrives to the checkpoint and verifies the truck within few seconds. That would be improved the facility of not having traffic problems when there are many trucks arrive to the checkpoint at the same time. Once the sand truck is passed the checkpoint after the process of identification, the current location of the sand truck is sent and displayed on the mobile application which has handled by the truck owner and the special alerts are sent to the mobile application. The mobile application is facilitated to add, update, or delete the schedule of the sand truck, view the user profile, adding truck details more than one truck etc. to the users who has signed in as the owners of the trucks. The details of the mobile application are stored in firebase under cloud Firestore with the set of collections. The cloud Firestore is a flexible, scalable database for mobile from Firebase and Google Cloud Platform and it has been performed the real time database and keeps the data coordinated across the client mobile application through the real-time listeners and offers the offline facility to support for the mobile application. The problem of the mobile application is the map of the GPS location is showing the dark mode for a while once get into that. Itiss a classification of API key problem.

The following areas are covered under this project.

- Setting up the login authentication using Firebase The mobile application is allowed to sign up or login via the username and email. These two parameters are authenticated by using the Firebase. The entered sensitive login or signup details are highly secured in the Firebase and it is a real time database which facilitates the efficient data. The security and accuracy level of the data is high when using the Firebase as the authentication method for signup and login to the eSand Transport mobile application.
- Setting up the truck details to the Firestore The truck details such as vehicle number, weight with sand is stored in one of the collections in Firestore in the name of 'truckDetails.' The details are added by the user who has logged into the mobile application via their login authentication and the added details are retrieved in the screen of mobile application. The entered details are possible to update or delete from their account.
- Add owner details to the Firestore Once the signup and login is successfully done, the truck owner who performs as the user in the mobile app sis allowed to create their user profile and all the details are stored in one of the collections in Firestore in the name of 'users.'
- Provide schedule to update the daily route The calendar is facilitated the add their destination with the truck number on the selected date and the added details are stored in one of the collections of the Firestore in the name of 'schedule' and provide to change or delete the added details in schedule sector.
- Truck recognition According to the specific ID number from the RFID card is allowed to detect and verify the truck details, schedule, owner details and the exact weight of the truck when it transports the sand. The RFID scanner is located near to the checkpoint. When the sand tuck is arrived near to the scanner which locates near the checkpoint is started to detect and verify whether this sand truck is having any inappropriate action against to the entered data into the Firestore. Once the scanning is successfully ended, then the police officers are confirmed, there is nothing wrong with the sand truck.
- Weight measuring the sand truck When the sand truck is arrived near to the RFID scanner, then the load cell is started to measure the current weight which locates under the ground level. The tires of the sand truck must relate to load cell. And this moment there is a comparison between the current weight of the truck with sand and the entered weight of the truck with sand into the Firestore.
- Detecting the truck, The RFID card is scanned by the RFID scanner once the truck is arrived at the check point.
- Provide the special alerts, GPS location of the truck etc. The current location of the selected sand truck is displayed through the mobile application to the truck owner. If there is any trouble while scanning the RFID, then the special alert messages are sent to the mobile application as notification via the phone number of the truck owner. The alert messages are provided to the mobile application and owner can get information about the selected truck.

3.3. Objectives

The following areas are covered under this project.

- Setting up the login authentication using Firebase The mobile application is allowed to sign up or login via the username and email. These two parameters are authenticated by using the Firebase. The entered sensitive login or signup details are highly secured in the Firebase and it is a real time database which facilitates the efficient data. The security and

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- Detecting the truck, The RFID card is scanned by the RFID scanner once the truck is arrived at the check point.
- Provide the special alerts, GPS location of the truck etc. The current location of the selected sand truck is displayed through the mobile application to the truck owner. If there is any trouble while scanning the RFID, then the special alert messages are sent to the mobile application as notification via the phone number of the truck owner. The alert messages are provided to the mobile application and owner is able to get information about the selected truck.

3.4. Requirement and Techniques

Throughout the typical techniques of gathering requirement information was the interview which had used to select a random truck owner for the purpose of gathering requirement information. Even though, the interviews were handled as unprofessional because of reducing the stress level of the random lorry owner. Not only interviews but also research was the next requirement gathering technique which had used to gather the important points. The reasons like busy schedule and stressful, the truck owners are avoided to the interview at the very first time. However, all these interviews were about held to specify the current process of their organization which used to handle the sand trucks and the effectiveness of the current system for the users like truck owners, drivers and police officers who had used to handle the system manually.

The sand transporting is a large-scale business organization which has been handled by the GSMB. The huge quantity of sand trucks is transported the sand daily according to their specific time and the allocated destination. The allocated time is decided by the GSMB, like the trucks

which have more than 3 cubs' deck then it should've to transport the sand during the night-time (6.00 p.m. to tomorrow 6.00 a.m.) and the below trucks should've to transport the sand during the daytime (6.00 a.m. to 6.00 p.m.) which have less than 3 cubs' deck. when their time is arrived, the entire trucks are started to travel on the same road until they arrive the checkpoint. Therefore, the traffic problem is increased during this periodand, the possibility of happening an accident is high. The sand trucks are checked at each check points until their destination is arrived, once the sand trucks are checked and signed by the main check point is not enough. By this process the allocated period is a kind of busy and stressful schedule to truck drivers because of they need to stop the truck and allow to police officers to check the truck which have checked by the main checkpoint. This is not the point, but the point is, transporting the sand at the allocated time slot is stressful to truck drivers because they've a responsible to transport the sand to the selected destination which has been ordered by the truck owner. If the allocated period is over, then the truck drivers need to stop transporting the sand until the next day. The above-mentioned points were the drawbacks which I have found during the research.

3.5. System Design

3.5.1. Er Diagram

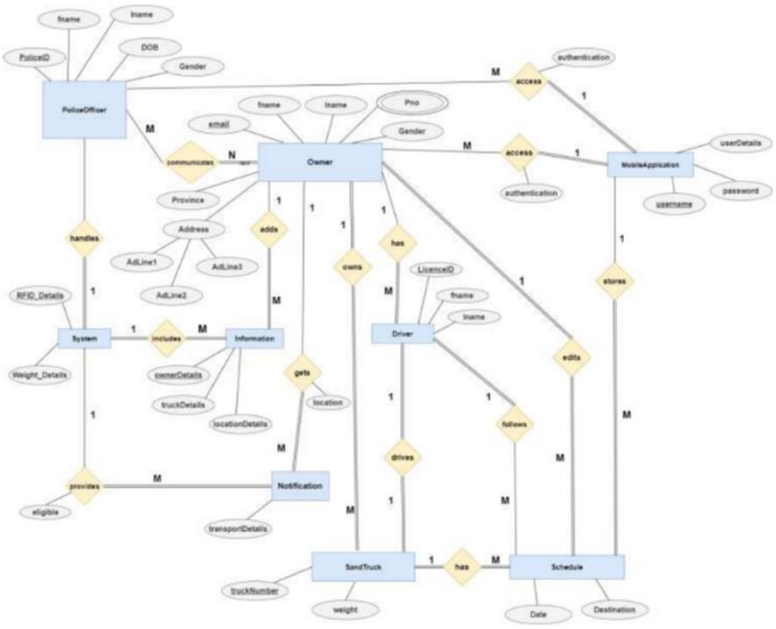

Figure 1 Entity Relationship Diagram for defining the process of the sand truck management system with the involved parties.

3.5.2. Use Case Diagram

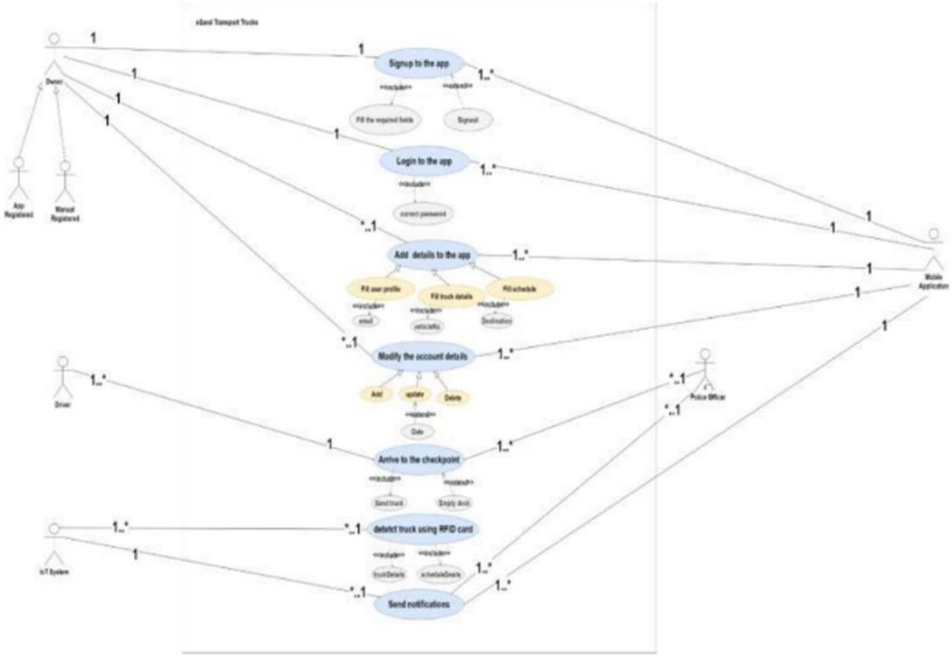

Figure 2 Use Case Diagram for defining the process of the sand truck management system with the involved parties.

3.5.3. Activity Diagram

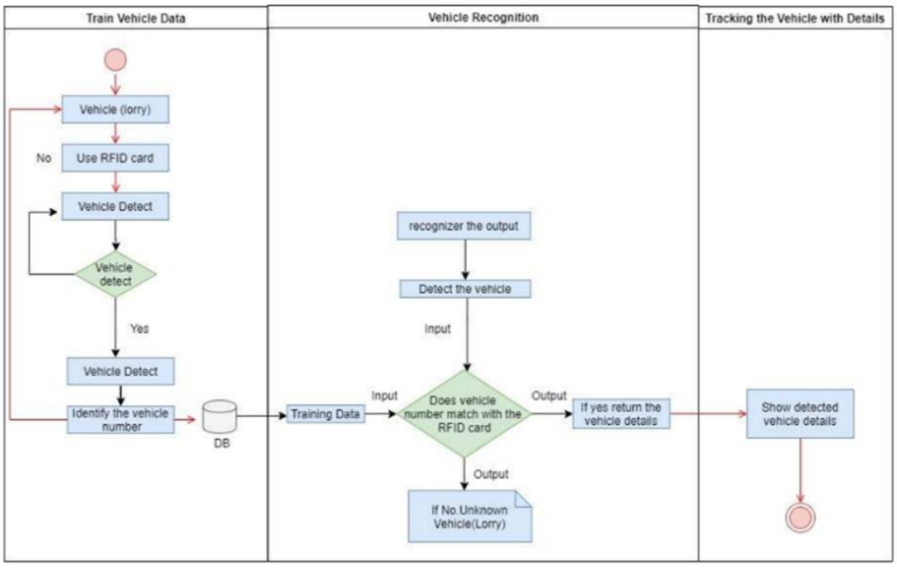

Figure 3 Activity Diagram for defining the process of the sand truck management system with the involved parties.

3.6. Required Components

IoT based RFID sand truck identification system is used Arduino Node MCU ESP8266 Arduino & Firebase cloud platform. The RFID cards are scanned by the Arduino and RFID scanner and then log into the data to Firestore through the Firebase authentication cloud platform with the support of ESP8299 Wi- Fi module. The information which are identified by the RFID, can be displayed in the Firebase and possible to access the authorized parties to view and identify the detected sand trucks over the internet. The IoT based RFID Sand truck identification system is required the components.

- Arduino Nano
- MFRC522 RFID Scanner Module
- 13.56 MHz RFID Card
- NodeMCU ESP - 12E Board
- Load Cell 20kg
- HX7111 Amplifier Module
- 6 x 2 LCD Display
- Load Cell Assembly Base
- Breadboard
- Jumper Wires
- A computer with
    - Dual core processor (Minimum)
    - 1.5 GHz (Minimum)
    - 1 TGB RAM
    - 30 GB Hard Disk
    - USB Port

The required software resources are mentioned as below mentioned.

The Microsoft Windows Operating System is based with the entire software resources which has been used to complete the expected task of the final project.

- The Operating System: The expected system is required to be developed, tested, and implemented with the support of the operating system. The Windows 10 is recommended.
- Visual Studio Code the Visual Studio Code is used to implement the eSTSI. Code refactoring, code completion and debugging are the major features which has been covered by the VSCODE. The entire mobile application of the project is developed by using the VSCODE.
- Android Studio The fastest tools are provided by the Android Studio for building the apps on any kind of Android device. The official Integrated Development Environment (IDE) and designed for Android development.
- Android development environment kit (IDE) and software development kit (SDK) platform tools The SDK toolset enables to create the apps which include libraries for building Android apps, a debugger, an emulator, and Application Programming Interfaces (API). The SDK tools are platform independent.
- Flutter Framework the Flutter UI framework is used for the purpose of phasing high quality interfaces.
- Firebase is a platform which has used for mobile application and web application development and provides tools and services to develop high quality applications. All signups and logins are based with firebase authentication.

- Cloud Firestore

  The Cloud Firestore is used for the purposes like flexible, scalable with NoSQL cloud database for the purpose of storing and syncing data for client and server- side development on mobile applications development from Firebase and Google Cloud Platform. The collections are created under the “testdb” in cloud Firestore.

- Arduino IDE The Arduino IDE is required in order to implement the IoT device of the project which has indicated the open-source electronic prototyping platform.
- ThingSpeak is used to share the data to the Internet which has provided by the IoT device.
- Dart The Dart is interacted with the flutter framework.
- AdaFruit.io The AdaFruit.io is used for getting the write API key for authentication purposes in IoT device.
- Microsoft Word All the documentations of this project are required to complete effectively use Microsoft Word.

When the mobile application and the IoT device is developed, the human resources will be needed to execute the usability and the quality of the functionalities in the entire project. The execution must be high realistic if the RFID card is tested with the real time IoT device.

4. DEVELOPMENT OF THE ESTSI

4.1. Description

Weight Measurement: The axel weight or gross of the passing sand truck is able to measure dynamically by using the sensors installed in the ground level of the specific pavement. The typical measuring method of this is interacting between the truck's tires and the sensor. This typical measuring method is an inaccurate method because the entire tire patch is not able to cover by the sensor. The Weight-In-Motion method is suitable to get higher accuracy weight measure of the selected truck. The wheel load of the entire moving sand truck is caused by the pavement strain. The time duration for longer forcing is covered by this WIM method. The pavement strain is considered to expect for getting higher measurement accuracy. Load cell measurement: The horizontal load and the narrow space measurement are the possible measurement for this project. Therefore, the sponge cell is confirmed to use instead of using the organism soft tissues. Vehicle Weight: The automatic vehicle load monitoring and navigation monitoring system are designed by using much equipment. But the in order to the qualities, the load cell which acts as weight sensing device is attached to the bottom of the sand truck, the suspension springs of the sand truck is attached with the weight sensing device as known as load cell, To convert the load cell resistance into the voltage then the weight sensing device is attached with conversion unit to convert the output as resistance, the voltage conversion unit and the automatic vehicle location data, the sand truck location data and the voltage data are received to AVL for connecting with the central server, The driver of the sand truck is communicated for the purpose of sand truck location data and sand truck load simultaneously.

4.2. User Interface of the Mobile Application

For signup in mobile application, the username and email are required to fill before login to the signup. The signup and login are based with email authentication through the Firebase authentication. The signup details are sent to the "testdb" which includes in Firebase and authentication by using the email. The purpose of including only two field elements to the signup because this application is used by the truck owners who busy with their day-to-day sand transportation schedule. Therefore, preventing to waste lot of time to fill the fields. Having two fields with accurate authentication and high secured data store process is the best rather than having many fields to field for signing up into the application.

Figure 4 eSand Transport App- Signup

Figure 5 eSand Transport App- Login

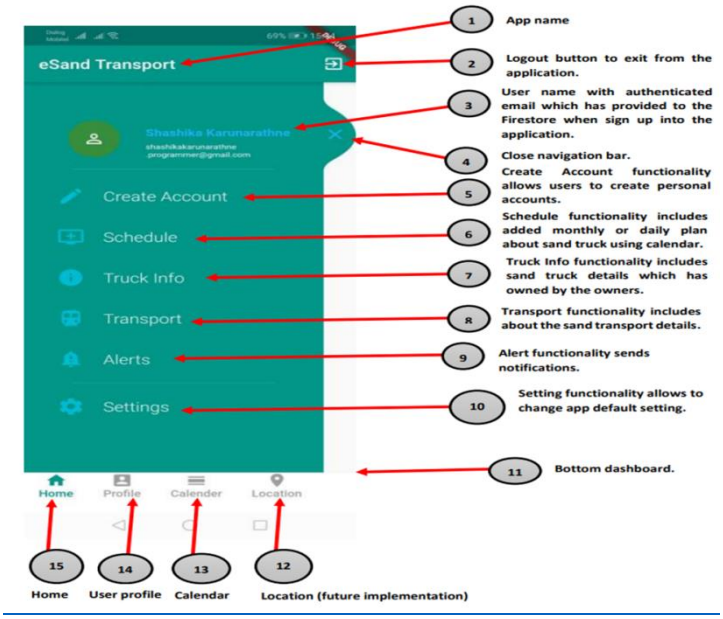

Figure 6 eSand Transport Calendar View

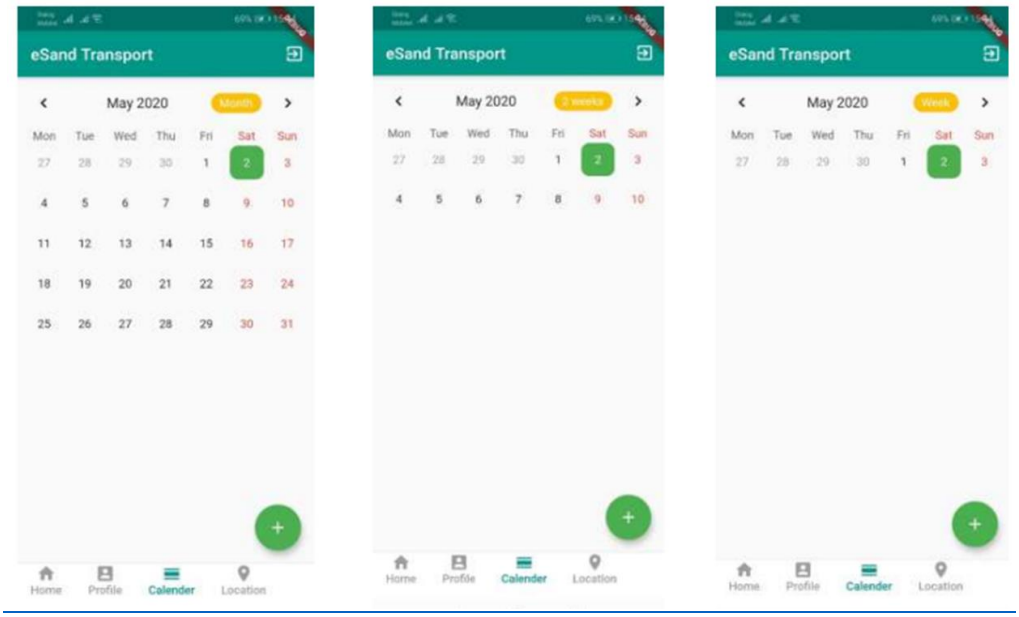

Figure 6 eSand Transport Calendar View

The user is allowed to add schedule when clicking the bottom left flat button, the dialog box is displayed which has indicated save button. User is possible to add destination with allocated sand truck and click save button. When clicking on the date which has added the schedule, the added details are displayed such as sand truck number and its allocated destination for selected date.

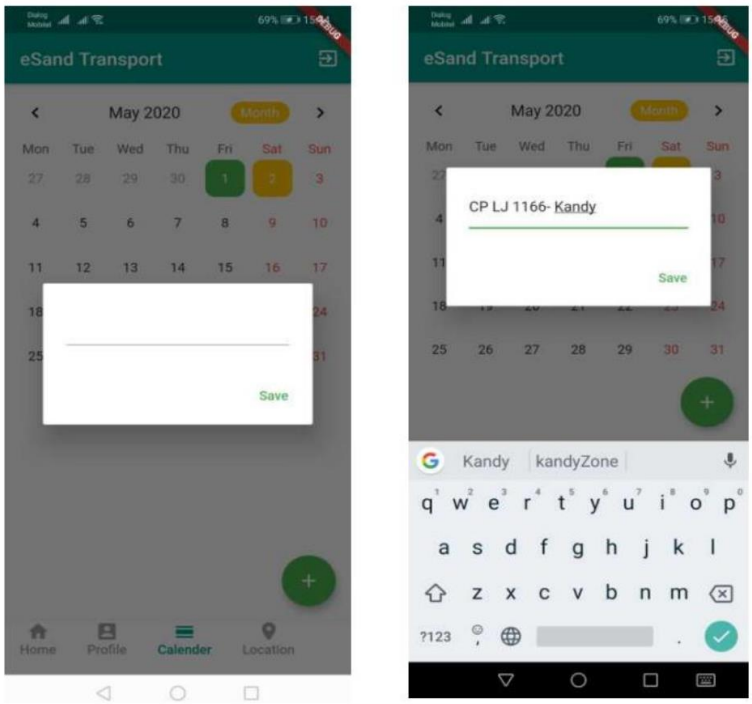

Figure 7 eSand Transport Calendar- added schedule.

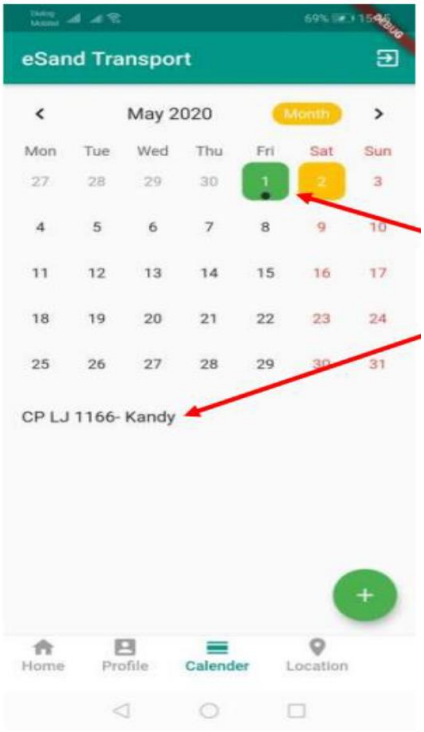

Figure 8 eSand Transport- View added schedule.

When clicking the Create Account functionality, the following interface is displayed, and all the fields are required to fill before submitting the details. If not, the notification is viewed that the field is required to fill. After adding the personal details in all the fields, users are allowed submit and the added details are stored in Firestore “users” collection.

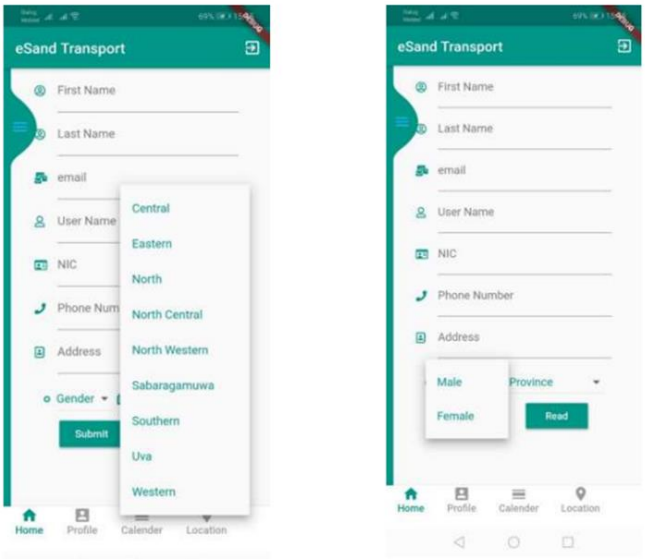

Figure 9 eSand Transport- user account create option.

When clicking “Truck Info,” user is allowed to add their sand truck details with the exact weight including sand. These functionalities are performed in one button which calls as “Floating action button.” This button includes three functions such as add, refresh and close.

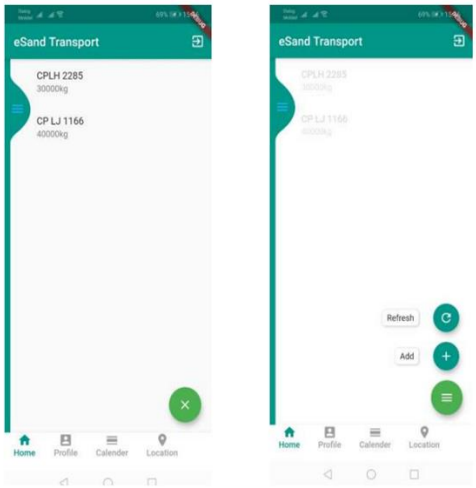

Figure 10 eSand Transport App –view the truck info.

The added schedules are able to update or delete functionalities as well. For updating, the user needs to select the field and click the added field which desires to change added data. After updating the field, the dialog box is displayed as “Job Done, added, Alright.” For deleting an added schedule, the user needs to long press on the selected field which decide to delete. After long pressing on the selected field, it will automatically delete from the application and the entire Firestore collection.

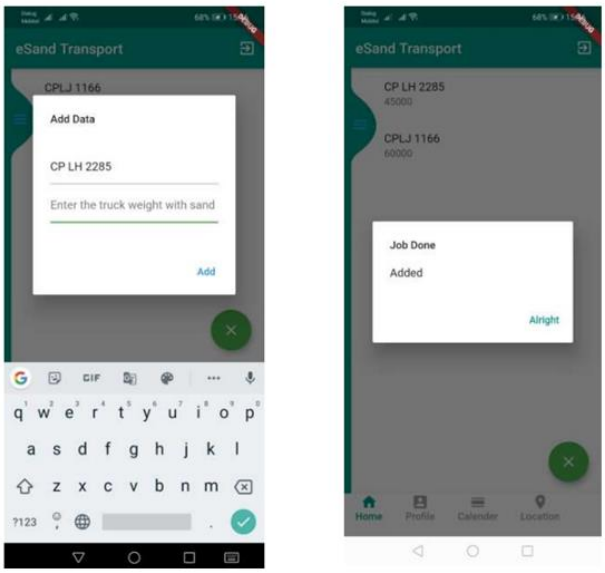

Figure 11 eSand Transport App- update schedule option

4.3. IOT Module

IoT based RFID sand truck identification system is used Arduino Node MCU ESP8266 Arduino & Firebase cloud platform. The RFID cards are scanned by the Arduino and RFID scanner and then log into the data to Firestore through the Firebase authentication cloud platform with the support of ESP8299 Wi- Fi module. The information which are identified by the RFID, can be displayed in the Firebase and possible to access the authorized parties to view and identify the detected sand trucks over the internet.

Proudly, looking at the project Sand Transport Management System using RFID and Load Cell technology is able to show how far the hard work and knowledge are performed to achieve the expected task into real. The modern and exist technologies are required for the Sri Lanka to develop the country into a better tomorrow than yesterday. By this point, this sand transport system with RFID and Load cell technologies is a system, which has still fresh and modern technologies to our country Sri Lanka. This system is able to invent which has required for the developing countries like Sri Lanka and other countries. When working with RFID technology, before applying to the system there are a lot of parts to study and apply the correct one to the project. But the RFID technology is the most effective method for identifying the sand trucks rather than using other technologies. There's huge amount of knowledge to study about the RFID technology. But it was quite simple when working with RFID after having enough knowledge about the RFID and its technology. The IoT device is included many technologies not only RFID and Load Cell but also Thinkspeak, Adafruit.io, Firebase etc. The Thinkspeak is used to send the data from IoT device to the cloud to store and secure purposes. The Adafruit.io is used for getting AIO Key and username to add into the IoT device. The Firebase is used to connect both IoT device and mobile application. And also, it used to login and signup authentication purposes for mobile application via email authentication. The mobile application framework is from Flutter which has developed using Visual Studio Code and Android Studio. And the Firestore is used to create collections to store the data which has arrived from the mobile application to store the data in high secure level. By these points, I am happy to use my strengths to do this kind of project for developing even when there are limitations and challenges to finish the expected task into real.

Figure 12 IOT Device model

Figure 13 IOT model

Figure 14 IOT device model- the process of reading the RFID: UID to grant the sand truck and displaying the 16*2 LCD display.

Figure 15 IOT model- view

4.4. ESTSI Compared to the Current System

This eSTSI project is concerned about to develop the computerized system with truck recognition IoT device and the smart mobile application to get rid from the manual system which had used to be signed the sheets when the sand trucks are passed the checkpoint. This system is aimed to provide the expectations of the users like truck owners and police officers who handle the process of sand transporting, as well as prevent their limitation due to lack of memory loosing of storing the data using physical things such as permit sheets and prevent for having large scale storage areas to store their physical permit sheets. The project domain has initiated the development of eSTSI is vehicle recognition authentication and firebase authentication for verifying the exact data with the selected RFID card which has assigned for specific sand truck. Basically, the development is carried out from concerning to provide the reliable and effective sand truck system where is has installed. This system which includes the mobile application and IoT device is capable to authenticate the users in both items. The process of authentication in mobile application is authenticated the users by using the Firebase cloud platform which users are login or signup to the app using their emails and which users have their details enrolled in the Firestore collections. The process of authentication in the IoT device is authenticated by using the RFID technology. The authorized person like police officers is handled and controlled the entire process. Once the enrolment is done, the users are allowed to use the mobile application without having the support from any outsider. The mobile application is facilitated to edit records in the user profile, get the current location of their sand truck, add schedules using the calendar view option, add truck details etc. to the users. When the details are added, then all the data stored in separate collection of Firestore with Firebase which has cloud platform and real time database. And also, the necessary details are retrieved on the separate screens on the mobile application when clicks the specific action buttons in the application. eSTSI is not aimed only for the sand transport system but also this might be useful to relevant sectors like harbor, public transport etc.

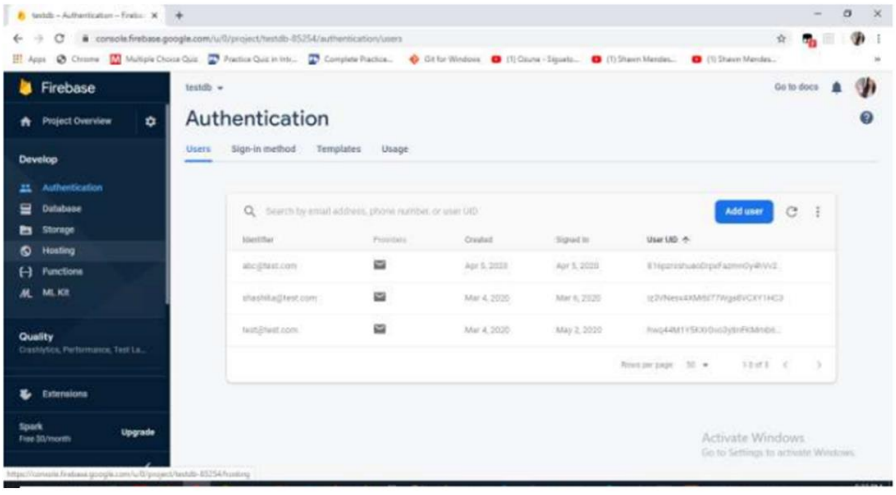

Figure 16 Firebase authentication (email authentication)

The collections are created to store the data which sends from the mobile application and the collections are created through the Firestore in Firebase.

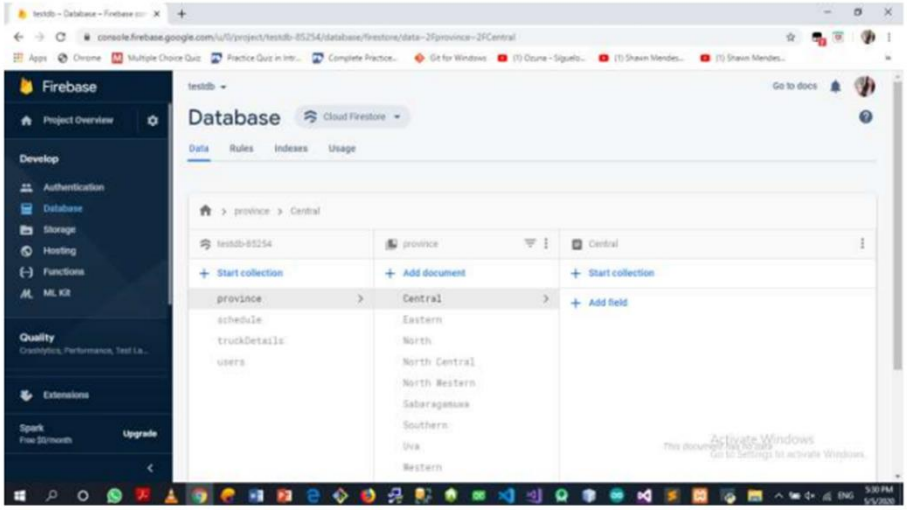

Figure 17 Firestore used collection.

5. CONCLUSION

The initial objectives and the expectations of the eSand Transport Management System with IoT Based are achieved effectively when it in conclusion is possible to guarantee. The sand truck management system is provided the huge quantity of tasks which convenience to the included parties. The time is possible to save by both parties such as sand truck management authority and the sand truck owners. The vehicle recognition by using RFID technology is the most effective method for the modern world for preventing the time wasting and prohibitive cost. The Load Cell technology is used to measure the current weight for comparing the current weight and the entered weight for the system. The eSTSI project is covered the initial scope effectively. The objectives and the scope which has included in eSTSI achieved successfully. This project is not only for academic task which has gained but also related the project process which helps for developing skills such as resource management, time, working under pressure and decision making.

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