School of Computing and Mathematics

PRCO303SL

Final Stage Computing Project

BSc (Hons) *Software Engineering*

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Smart Electricity Meter

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Abstract

E-meter is a smart solution to replace conventional electricity meters found in our houses while providing smart features like real time usage, online billing, controlling power remotely, notify users of possible power outage. Furthermore e-meter going to introduce smart prepaid system to be used in homes, hostels, and hotel rooms. E-meter includes a completely redesigned electricity meter and a web application with remote server which not only connect consumers and service providers but also feed live data and helps to assign limitation to electricity usage. It records all the data of each customer and provides bill payment through online system and provide full control of the meter to service providers. We can remember there is a person visits our houses once a month to read the electricity meter and issue a bill. This person must cover area by area just to read the usage. Occasionally this method leads to errors, especially people experienced this in Covid-19 situation where electricity board fail to send anyone to record usage in most of the houses and they could not record the usage for two to three months. This leads to a various chaos in the system like, extra bill amount, no specific usage just guessing, and all these problems cause a big loss of income to electricity board. To overcome these difficulties and provide a smart and exceptional service to users we have research and developed this smart e-meter.

Keywords: smart meter, electricity, web app, prepaid system, real-time update

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Abbreviation

IDE	-	Integrated Development Environment
PCB	-	Printed Circuit Board
AVR	-	Automatic Voltage Regulator
IOT	-	Internet of Things
BPL	-	Broadband over Power Lines

1.0 Introduction

Changing the traditional way of electricity meters with smart meter. Provide a new and improved method to age old system in sri lanka. Collect and produce meter readings easily with issuing bills online which provides a user with all new control over their usage and providing client with complete control over system. This project focus on completely redesigns old electricity meter for a new improved electricity meter. This smart meter can do both collecting the consumption and sending that consumption to CEB database. Client do not need to visit each home to issue bill. Instead, they can issue bill online using their database. If one customer did not pay the bill correctly client do not need to send someone to disconnect the power from that premises. Instead, they can disconnect the power within their office through internet. Customers also get benefits from this project; the developed app was completely for the use of customer. They can see their live consumption and see the consumption history. When bill was issued, they can simply pay the bill. This project completely helps both customer and consumer to do their works in a smart way.

1.1 About the Project

Introducing a **smart meter** system to Sri Lanka's domestic old fashioned smart meter. In this project, developer planned to develop an online meter reading application online billing system online payment system and power outage showing system for customers.

Administration side include, developing online power controlling on/off system, updating, and communicating with customers and a research was ongoing to implement a prepaid system to electricity meters where customers can reload their account and use electricity as they pay. This research is still going and results and knowledge that gathered will be discussed further in the report.

Creating a bill was planned to do online through web interface but client hopes they need old approach like solution to this, so developer have introduced text messaging system to the same project. In this method my system will send a text message to both client and CEB the number of units that consumed by customer so that they have access to the information if something goes wrong. This is also another risk prevention system which is not relying on one method always when dealing with sensitive data.

Study on tariff system to calculate the bill was completed and I have planned to develop this system only for domestic usage where block tariff system is used. Security concerns were taken very seriously, further information's are discussed later in the report for more clarification.

2.0 Background and Motivation

2.1 client needs

Client still relying on the old method to collect domestic usage. They need more reliable and smart approach to the situation which will save their time and money and also big part of the system is controlling customers activity remotely. They also expect to connect with customers to inform news and updates in a quick way. They need a platform to get questions from customers and resolve their problems easily.

2.2 Underlying problems

Both client and customer face problems with current implementation of the situation. When focus on the customer they do not have any control over their usage because their bill was given at the end of the month. So, they do not have any clue about their usage. If they had better understand about the amount, they have to pay at the end of the month they will be encouraged to use a smaller number of units in order to reduce their bill. But in current situation they must wait until the meter reading person to visit the premises and record the usage and issue a bill.

There are other problems that occur while doing a research on this matter like power interruption. Sri lanka is a country which still have many power interruptions happen in a single month even a week you can expect five to ten power cuts. In the current system customers does not know and about power cuts before. But if every user was registered to this application, then we can notify them before any power cut happen and this will help them to plan their work accordingly.

Starting with the project this uses many sensors to record the current flow and get the consumption, these sensors can be burned out. Project uses a system to design the circuit beforehand so if there is a mistake you cannot roll back if that happened you have to design all over again. We used firebase Realtime database and it’s no SQL database, even though its easy to connect with real-time database real-time database lacks querying. This happens to be another problem.

2.3 Client Objectives

To modernize customer experience and give whole new control to client administration,

- Remove the staff need to collect and issue an annual bill.
- Gives full control to client/administration.
- Measure and update the electricity usage online.
- Notify any problems with system automatically.
- Give easy approach to access the system.
- Create an automatic billing system.
- Connect and disconnect power as needed.
- Customer has better interaction with system via website or app.

2.4 Project Objectives

- To provide and enhance the control of the system.
- To control customer usage within the system.
- To reduce labour and earn productivity with cost cutting mechanism.
- To implement an easy and modern approach to the system.
- To implement new meter with more digitalize system than old system.
- To make the billing process automated and controlled.
- To analyse how system will benefit both customer and client and the problems they face while using old system.

3.0 Literature review

4.0 Method of Approach

4.1 Initial Scope

Product development will include two main things which are the smart meter and website/app for interactions. Project focus mainly on correct readings and data collection part in meter where designing circuit and include electrical pulse reading sensor along with other parts. This meter will read the kWh usage and send the data to database.
Project use Atmel studio with C++ as main coding IDE and language along with Eagle CAD for designing circuit. Designed circuit may print and all the parts are fixed into that board. Using the main microcontroller code will be implemented inside it and test. Now this meter will replace the domestic electricity meter. All the data that old meter get will be direct to this meter. Those data will be sent to database using GSM module.

Next part would be the interactions with user or customer where developer plan to use an online application along with a web site which has an updating database with two separate logins for admins and customer. Data which was sent by meter will send to firebase Realtime database where it stored according to user. These data will be retrieve again as requested.

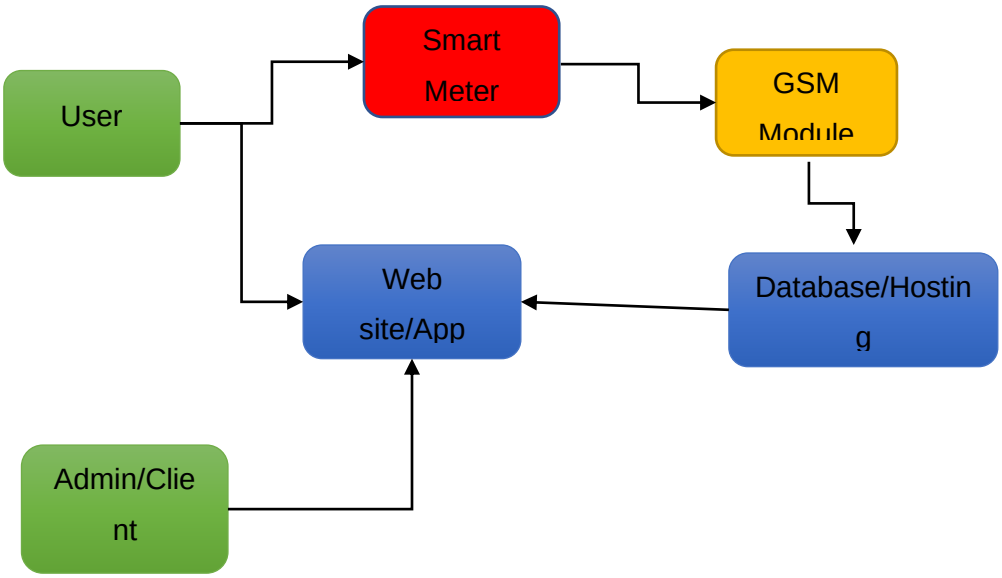

Figure 1 sample system design

After stating the project its recommended to decide an appropriate system developing life cycle. Then developer used following SDLC models. There are waterfall model and agile model.

4.2 Waterfall Model

Waterfall model is easy method of implementation which brings more sequence approach to the development process. Developers need to have proper understanding of the project and all future implementation and made them available. Using this model gives benefit to clients as it will properly describe the project and money estimation can be done accurately.
Even though this waterfall method was easy to use it has some problems too, like we can't change the scope. This will lead to budget overrun and system will face problems. when developing project developers need to consider these too.

4.3 Agile Methodology

Agile methodology can be called as improved version of waterfall method. This method helps with team members collaboration. This method mainly focusses on user and keeps the project on planned budget. All the main tasks are divided into smaller tasks and deliver part by part.

Scrum meeting will be taking place in order to complete these small tasks scrum master may take the responsibility, he will ensure team coordination and collaboration. One meeting will be 20 – 30 minutes. These meetings may help developers to check progress.

4.4 Development approach

I mainly rely on waterfall methodology and combine agile methodology to manage this project. The project was divided into stages in order to complete it efficiently. Project initially started in around September and completed within six-month time frame. PID was created in the beginning of the project. main development focus was never changed but some parts were changed, and new ideas were adapted along the time to complete this project more efficiently. Research has been done to get an idea about current system in sri lanka and collect social information gathering to get idea about people's feedback. Every month as possible meet with supervisor to show the progress and get his advice on project and added new features. While developing mainly focus on the backend because success of that part crucial for full project. backend of the circuit was developed and tested many times and then move on to do the front end.

- Requirement Analysis: First I research on my idea and is there any approach done in the market. I discovered there is no system like this in Sri Lanka, but several other countries have implemented same systems in their countries. I go through these systems and get some idea about how they implemented this and how it affects both customers and client. How they evolve the system to reduce problems and what kind of approaches they have taken.

- System Design: I designed the diagram according to the knowledge I have gathered from my research. Then go through various systems to implement last project. it's clear that people need easy approach like mobile application and client ask for easy control to complete these tasks I have developed mobile application along with the option to client to access.

- Implementation: implemented the mobile app using java in android studio. Databases need to be used to store data that sent from e meter, for that Firebase has been used. Client has separate login to the system.

- Testing: completed the mobile application and connect it with firebase and tested to check whether it is sending data correctly to the database also app was given to several persons and record their feedback.

- Maintenance: maintain and improvement done every day as needed like UI/UX improvement will be doing even after implementation.

4.5 Tasks Undertaken and Outcome Produced

Task ID	Task undertaken	Produced actual outcome	Overall Weight %
1	Implementing an automatic text message system	Completed and tested several times with 100% working	80%
2	Classes and libraries are coded and completed for circuit	Classes for all the electrical components are done	50%
3	Electrical pulse reader bought and coding to get the accurate unit of usage	Not completed, under testing 05/01/2021	5%
4	Database integration with firebase	Undergoing some changes can finish within few days from the report creating date.	100%
5	Research study on electricity system	Various knowledge gathered from research and still researching on new technology	40%
6	Application interface including all windows are completed	Need to do some changes but mostly completed.	90%

Table 1 Tasks Undertaken and Outcome Produced

4.6 Anonymous Public Survey

This project is mainly relying on the customers who willing to use this. Currently they have a system so if our plan to implement this successfully we need to get the peoples feedback and suggestions. To complete that Google form was created and shared across msny people in

many social levels get the feedback. (results were visualized under the Appendix Anonymous Public survey)

5.0 Project Management

5.1 Version controller Used.

Version control or the source code management will be handled by GitHub. GitHub helps to backing up and storing source code and to pull the code as wanted. Git or same kind of version control has been used while developing the system.

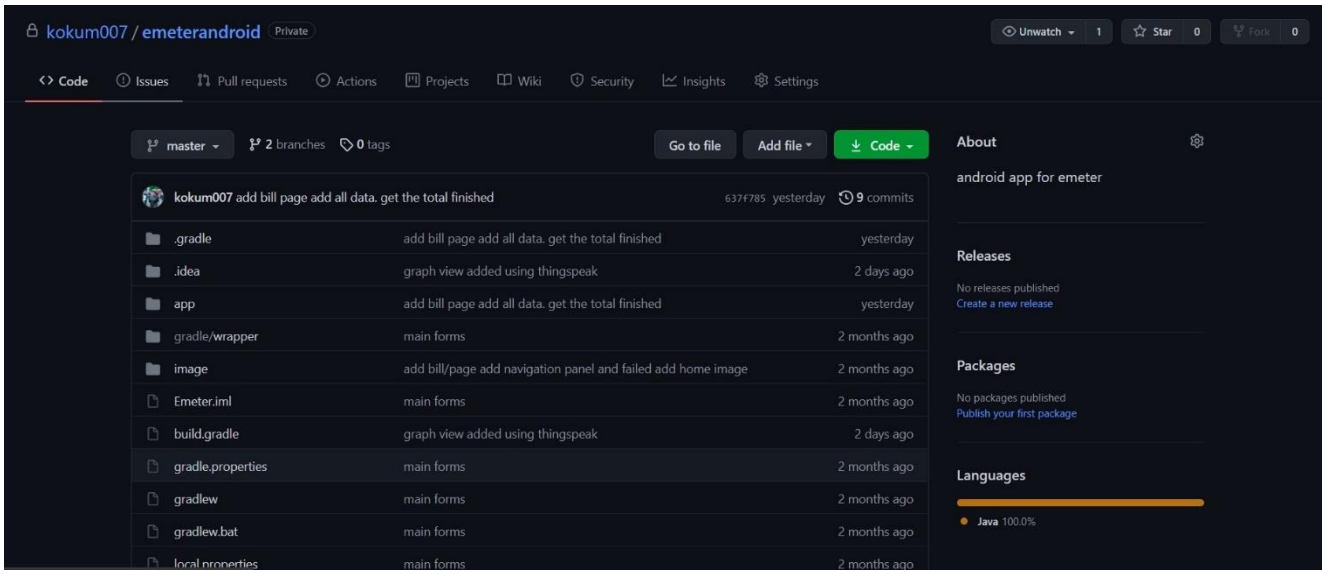

Figure 2 Version Control using GitHub.

5.2 Schedules and Deadlines

Stages	Schedule Date	Deadline	Outcome
Initiation process of the Project	03/11/2020	05/11/2020	PID report submitted.
Investigation and finding requirements	29/11/2020	03/12/2020	Studying completed on smart meter. Assessment of the records that have ready to run the program.
Designing of the High-level	10/12/2020	16/12/2020	Designing the Circuit and program it in such a way that it senses electricity pulse and output units.
Designing the user interfaces	20/12/2020	15/01/2021	Mobile application user interface design completed.
Increment 01	10/01/2021	10/02/2021	Connect GSM module to the system which enables the system to connect with the internet.
Increment 02	20/01/2021	14/02/2021	Data send to firebase and successfully get back to app.
System and user acceptance testing	20/02/2021	05/03/2021	Final system and user training
Assemble and complete final report	22/02/2021	07/03/2021	PRCO303 Report
Study of an established organization The Systems	25/02/2021	15/03/2021	Processes recorded
User requirements	16/03/2021	20/03/2021	
Validating conditions	06/03/2021		Client sign-off
Assessment of the possible Technologies for Growth	18/03/2021	30/03/2021	Brief study covering potential and possible problems Technologies

			introduced, consideration of problems, Reasons and triggers.

Table 2 Schedules and Deadlines of the project

6.0 Requirements

6.1 Functional Requirements

The functional requirements are divided in to three parts, core, desirable and optional. The core functions are required for the application without them application would not be complete. The desirable requirements include additional user functionality, even though they are not their application would still work. Optional requirements are elements that will most of the time not be present in the final system. This is because time restriction of the project. However, they can used as future implementations and to develop the project further.

6.1.1 Core Function Requirement

Circuit and GSM module

- I did not use Arduino instead of that I print a circuit this circuit along with the sensors I connected helps to collect the consumed units of electricity. I have used Atmega 328p microcontroller as the processor of the circuit.

Mobile Application

- Users can register for the system their name. their relevant information along with their account number was recorded.
- Users can log in to system using their registered credentials.
- Users can see their live meter reading.
- They can see last usage in a graph.
- They can view their bill which was updating online.

Firebase Realtime Database

- The data sent from smart meter sent to firebase under each user's account.
- Users sent data will retrieve once user log into system.
- According to send data, bill will create.

6.1.2 Desirable Function Requirements

Mobile Application

- Users can pay the bill using many implemented methods.
- More advanced graph develops to give more details.

6.2 Non-Functional Requirements

Nonfunctional specification is a different from technical requirements. Where those who consider functionalities of the application that customers care about may impact their interaction with system. This contains limitations and aspects.

Performance: the meter must work very efficiently because it planned to replace the electricity meter. And data that gather need to be sent frequently to the database.

Responsiveness: mobile app needs to be more responsive to the user and show required data to user. No space for any errors when calculating units.

Scalability: System need to work efficiently even there were more users log in to same system.

Usability: app must be easy to understand and easy to work with. It needs to have simple and recognizable interface.

Reliability: the program needs to be dependable without using many resources. Database must be working efficiently.

7.0 Design (UML) Diagrams.

7.1 Login page Activity diagram

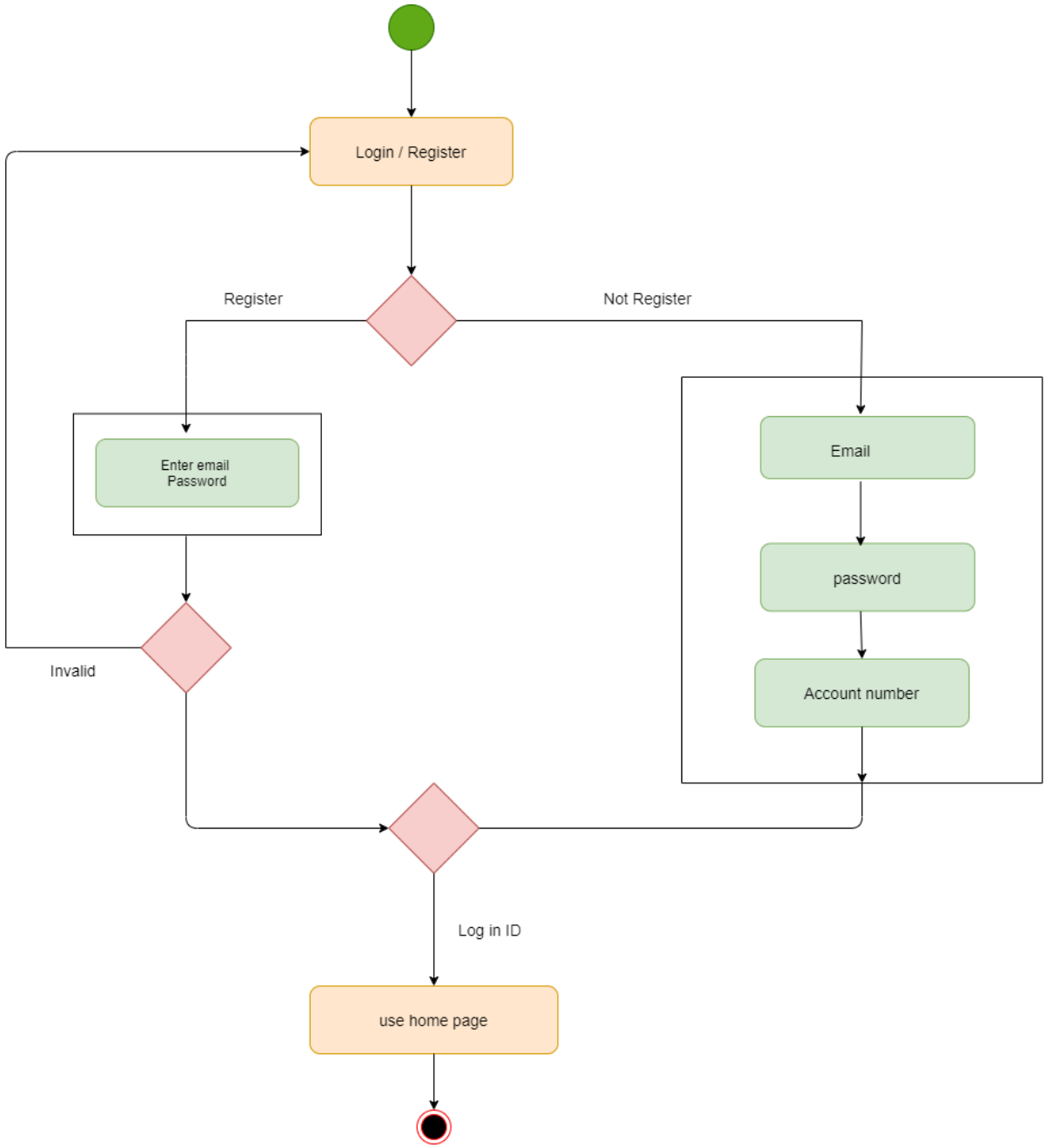

Figure 3 Login Page Activity Diagram

7.2 User case Diagram for the system

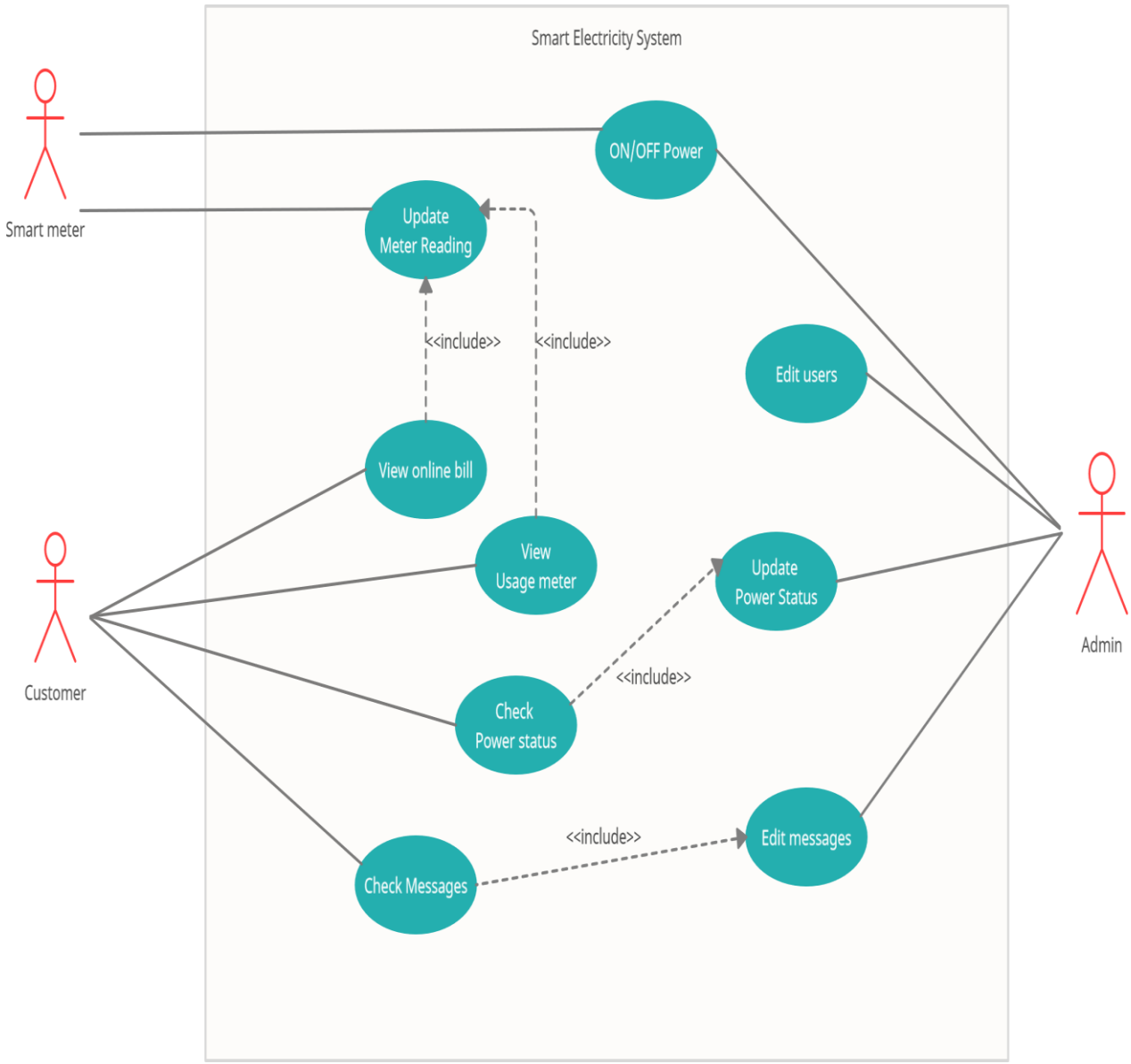

Figure 4 User Case Diagram

7.3 Component Diagram of the system

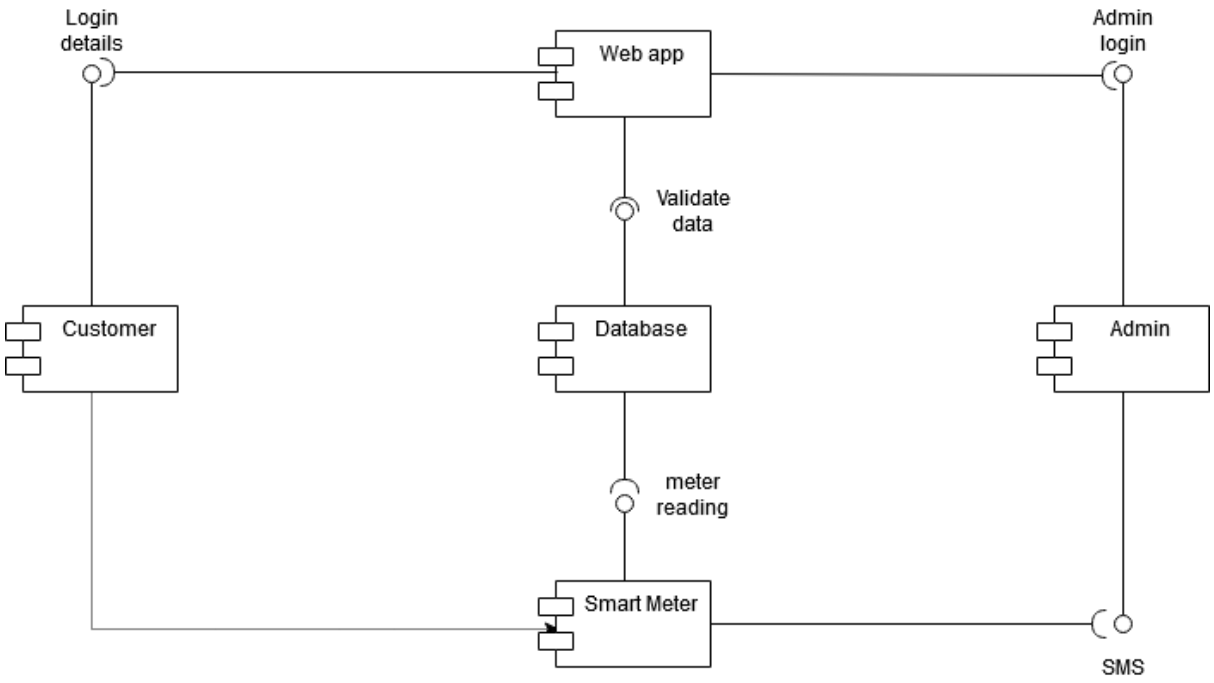

Figure 5 Component Diagram

7.4 ER Diagram

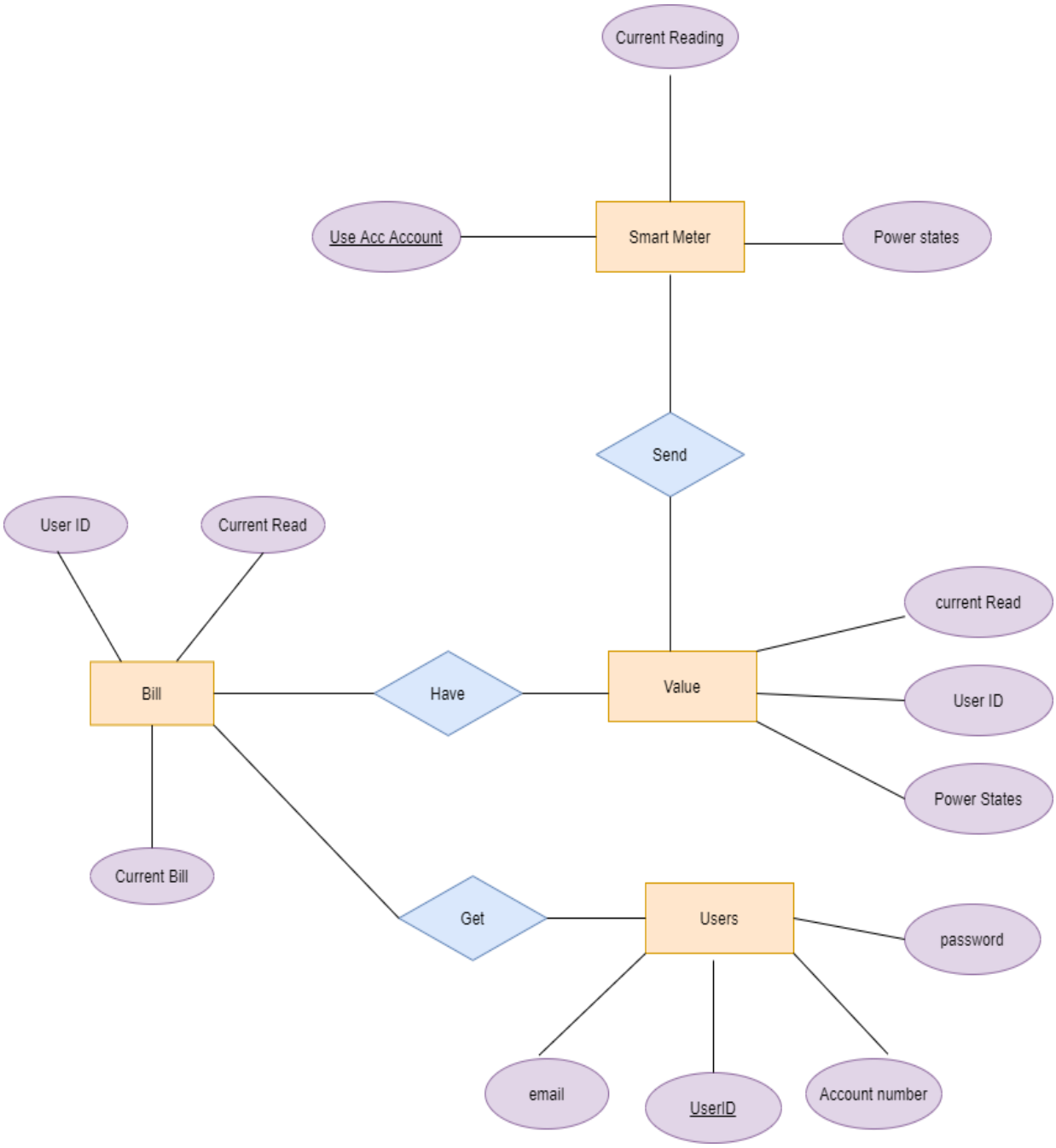

Figure 6 ER Diagram

7.5 Context Diagram

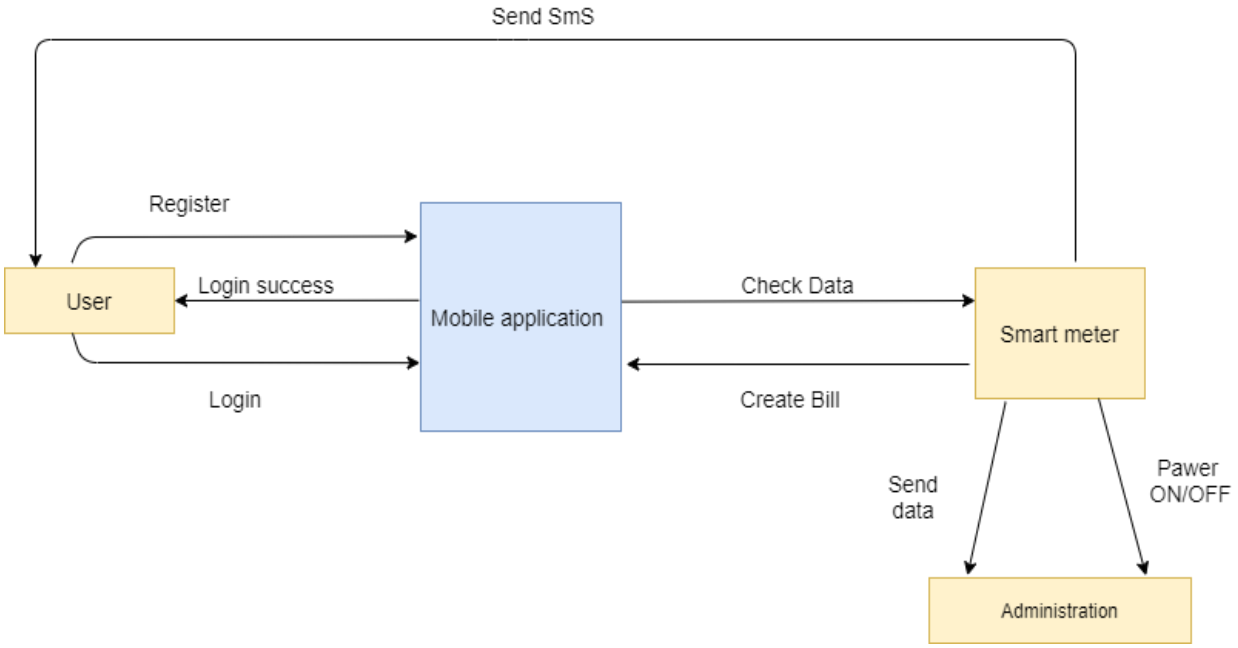

Figure 7 Context Diagram

8.0 Implementation

8.1 Front-End Development

Technical research has been carried out to find most suitable language to use to develop the mobile application and finally decide to stay on java language and use android ide as main ide and language. Java is object-oriented language which means it helps to properly analyse class, object, inherited, and so on. This improves the coding framework. Constructing OOP based mobile application is much simpler in some terms. It has unique qualities which highlighted and helpful to developers to use it. Java API s were used in this application and material design libraries to make it more convenient for user to use the application. **Thingspeak** library has been used to show the graph view of the usage.

8.2 Back-End Development

Firebase is the database service used in project. Firebase used to store meter reading in each frequency data has been sent to firebase and stored under userID. Firebase has many options but in the project use Realtime database. Firebase is no SQL database. It provides connection through firebase API which was https JSON format. Firebase authorization also used in the project which helps user login and registration.

9.0 Development

Whole project was able to come up to the standard which were planned before starting the project. Risk evaluation and considerations were correctly used which helps to keep the project on the phases and in the time frame and waterfall approach. Produced reports were used to set goals and properly evaluate the success in each phase. The obstacles face in each phase along with the goals that were achieved described in sub section of each field.

9.1 Phase 0

Summary:

Phase 0 was the very first implementation, and it concentrated on arrange things in place to develop circuit and IOT part. This involved creating the infrastructure, adding libraries to make the project work properly, and setting up version control systems with GitHub to save the project files as a backup tool. It was crucial this was all set up before starting the development. Because of this, it was decided to make this phase longer at a day.

9.2 Phase 1

Summery:

This sprint was completely focused on develop a simulation for the system. This time sri lanka was having covid19 problem because of that it was difficult to buy some of the sensors that need to complete the circuit. Proteus software was used to develop the simulation Discuss with the supervisor on the matter and develop a prototype system and tested everything.

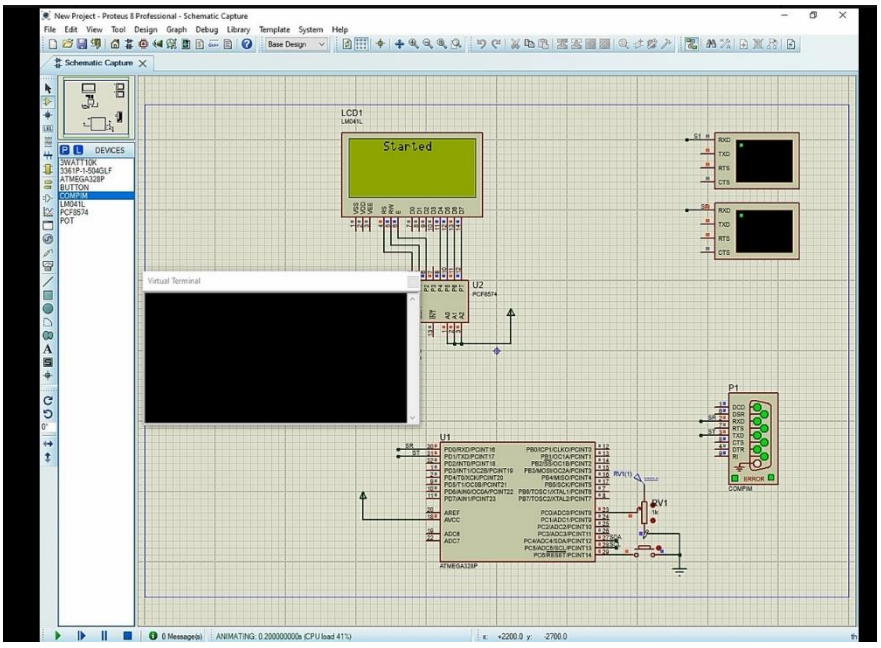

Figure 8 Developed simulation.

Goals achieved:

Phase 1 was successfully. Simulation works well. With the help of e commerce site, I was able to get the important part to create the system. Simulation helps me to understand the project scope while working.

9.3 Phase 2

GSM module was tested without connecting the main project. This project relies on GSM module, this unit helps to connect meter and database and it helps to send SMS to customer. SMS protocol need to be developed separately in a given limit or given time. (Figure 30 Appendix: GSM module Testing) Also, SMS will be sent to client at the end of the month.

Goals Achieved:

All the SMS part was complete and tested data connection was successfully implemented.

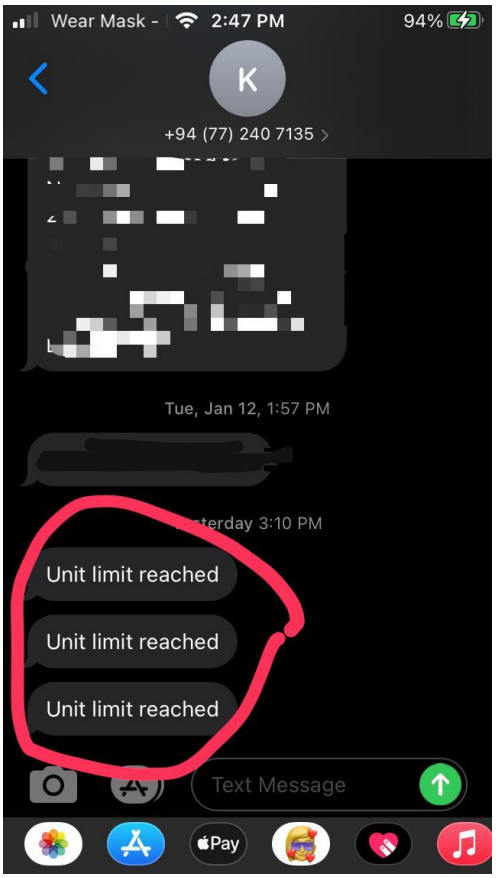

Figure 9 SMS Connection

9.4 Phase 3

Summery:

After all the basic components were checked and tested, started to create the physical smart meter. First use the Eagle cad to design the circuit.

Goals Achieved

Successfully design the circuit all components were check virtually. Move on to next part to print the circuit. (Figure 33 Appendix: Circuit Diagram)

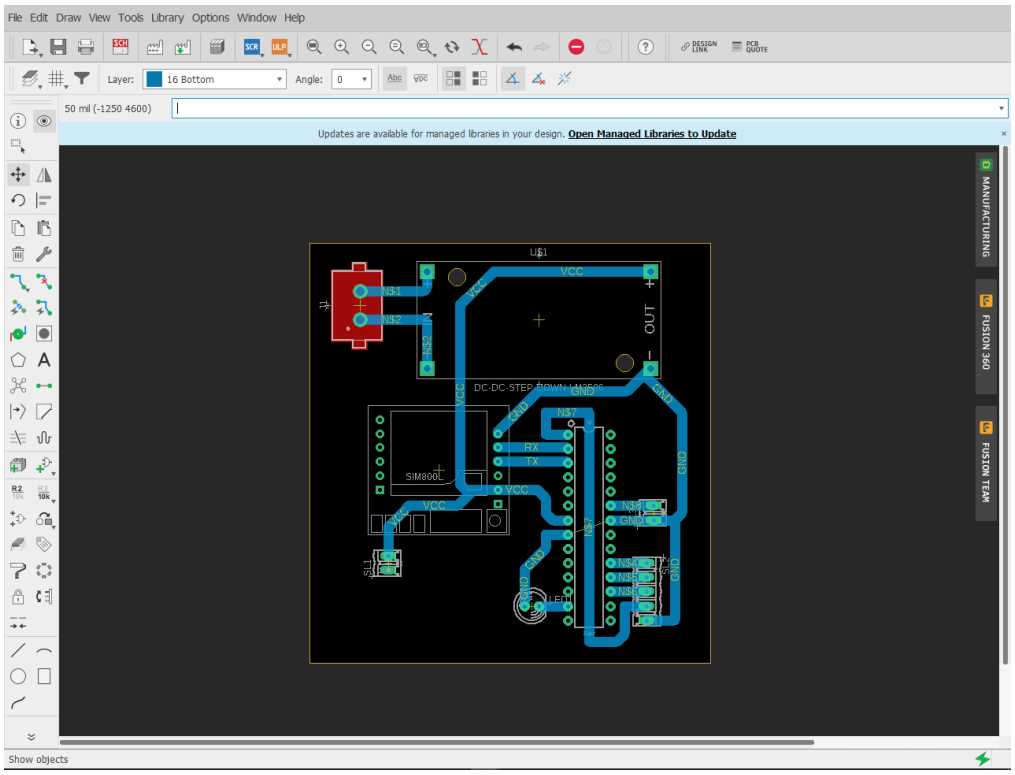

Figure 10 Circuit Design

9.5 Phase 4

Summery:

System was printed into photo paper. PCB etching method (technologies, n.d.) this method was further described under technologies (PCB etching) used and added all the components and tested with power all items were working correctly. Printing the circuit some kind of a hazzle as it takes much time, and several features were used. Tested several times to get the best output from the system to check whether it's working properly. (Figure 13 Final PCB)

Goals Achieved:

System was working completely. Gives all the correct data as planned. Check using different power sources, and all are working correctly.

9.6 Phase 5

Summery:

Now the circuit is finished and successful now its important to send the data to database. Firebase was planned to use and Realtime database planned to use because its sending data always.

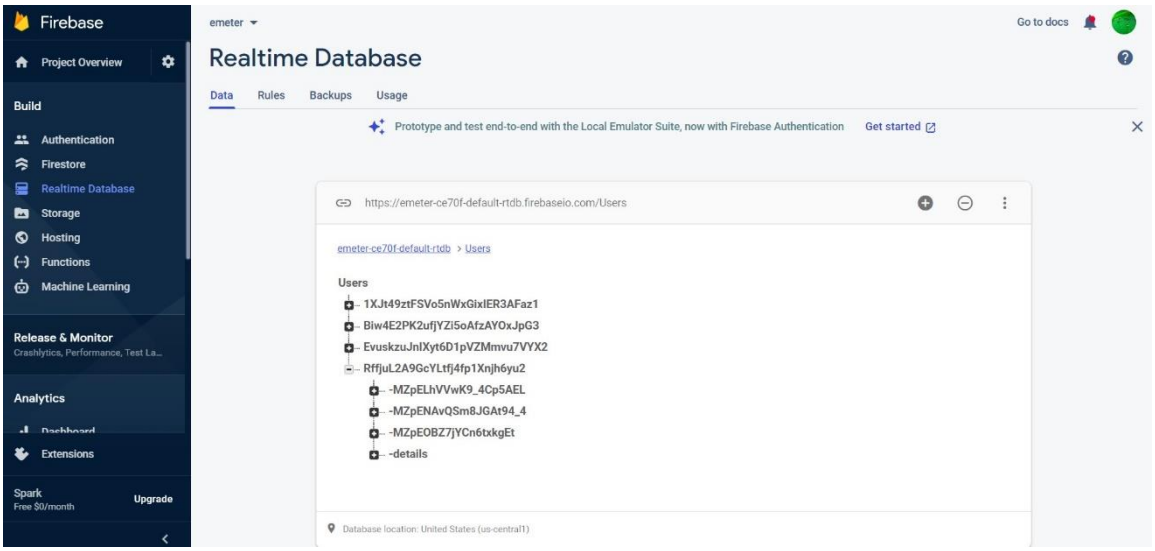

Figure 11 Firebase Database

Goals Achieved:

Firebase real time database was created and connect to the GSM module and test run several times to check whether it is sending data properly and also Postman was used here to test if the connection was completed using the JSON files. (Figure 27 Appendix: Postman GET requests)

9.6. Phase 6

Summery:

Now the real-time database connection was successful now we need to send those data to user. in order to do that mobile app was created user logins and registration also must send to the database under that particular user we need to collect the data sent from smart meter.

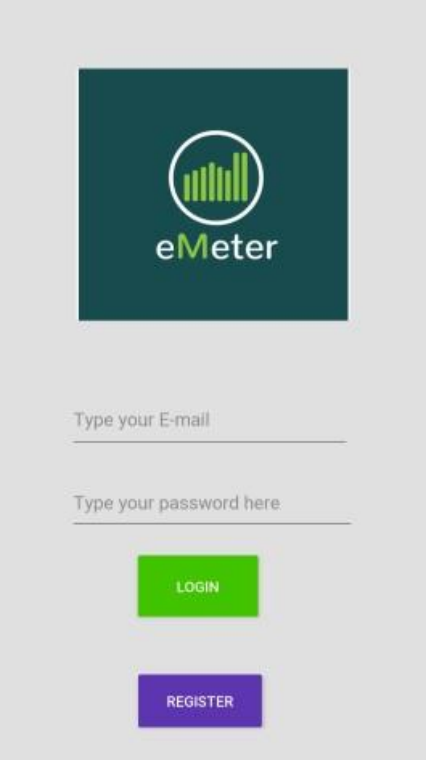

Figure 11 Mobile App interface

Goals Achieved:

Phase 6 was successful all objectives were completed. User screens were developed and successfully tested with database connection and it's working properly. (please check all the user interfaces along with graph and billing data which are available in Appendix)

10.0 Testing

10.1 Usability Testing

Usability testing differ from other testing's because it uses actual event and actual people use to test the project. Usability testing was performed many times in different scenarios and to test different parts of the system testing were took place between phase 2,4 and continue again in phase 5 and 6 and in completion of the system.

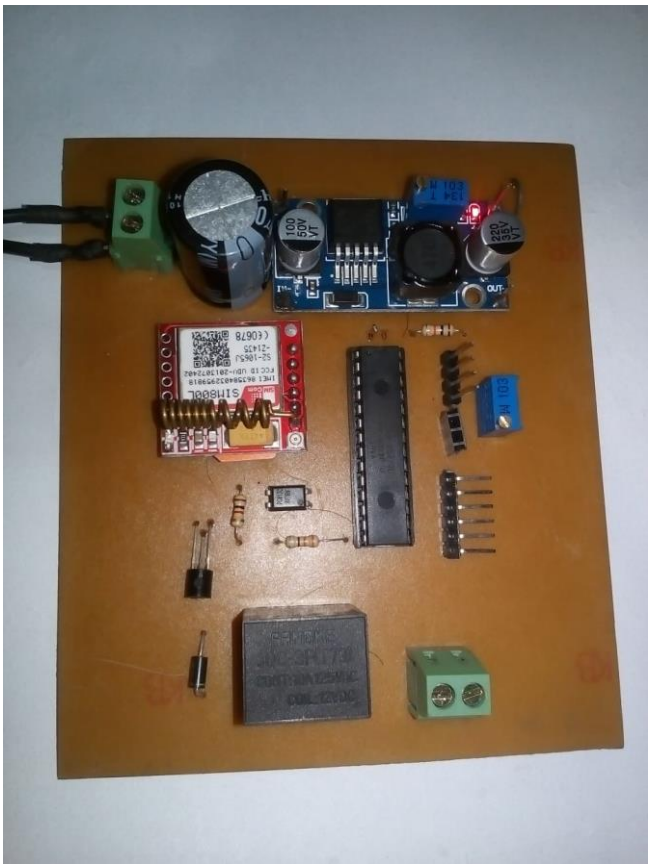

Figure 12 Testing the circuit.

After the main testing complete this need to be tested whether it gives correct reading similar to domestic meter. As this will completely restore the current domestic meter this need to be precise when recording the consumed units. After the tests perform it records data up to 5A normally in domestic CEB send 15A current. We can also use 15A sensors but if we use that, we can't get precise records when tested with small outcomes. So, it is possible to replace domestic meter with this one little improvement needed. (Figure 25 Appendix: Testing Output)

10.2 Testing and outcomes

Test Case Name	**Test case Step**	**Action**	**Test Data**	**Expected Result**	**Test Result**	**Note**
SMS mechanism	1	Get the meter reading	-	Took meter reading	Reading captured	Success
Send a SMS	2	Connect to SP	-	SMS sent	Receive SMS successfully	Success
Accurate meter reading	1	Calculate the unit reading	-	Collect meter reading	Read the accurate reading	Success
Start GPRS in module	1	Start GPRS	-			Success
Sending data to database	2	Send data over GPRS	-	Data sent to database	Data received at database	Success
Show the meter reading in display	1	Show the reading	-	Show the reading	Results displayed	Success but need more improvement
Display data in app	1	Display meter reading	-	Update web app	Errors occurred	Completed

Testing for GSM module is completely new to learn. So different kind of testing done. Because GSM module was used to do two different works like sending SMS and connecting to internet.

11.0 Resource Used/ Tools and technologies Used.

11.1 Atmel studio IDE

Atmel studio is a free development environment. It gives everything to edit, build, download and debug PCB or microcontrollers or other Atmel components. It has its own Atmel software framework. Developers can test and debug their code using Atmel IDE by connecting it to PC. It automatically identifies the connected hardware. This software provides direct link between micro controllers and software. Throughout this project Atmel IDE used in various times, first it was used to code. Then it was implemented into circuit and tested and then ide again used to debug the program and see the output it gives in various times.

Difference between Visual code and Atmel studio:
Visual code is also supporting to code microcontroller with installing some libraries. Atmel Studio is also the same kind of software, but it was more suitable to code microcontrollers like, the chip I am using was produced by Atmega. It gives more functionality when it comes to code microcontrollers and debugging support is immense. Visual code was not implemented specially to microcontroller coding, but Atmel is predesigned for that. Because of that it has many benefits. Visual studios disable the #defined conditions which is very useful, but Atmel studio does not do this. Atmel studio has built in simulator which is very useful on some occasions. Visual studios perform well with C++, but Atmel studio can effectively work with microcontrollers native language. Because Atmel know about their own microcontrollers.

Create the PCB Atmel studio used in many time codes mainly using C / C++ since ditching the Arduino from the core all the coding must done manually more time spent in creating some libraries as there were not to be found even in internet. Must do lot of work related to this. Continues testing must be done to make sure everything performs well. Atmel studio and its advantages against Arduino were discussed earlier but more than that when comparing with Arduino it gives us a certain limitation on microcontrollers and we can’t explore more than that its like MacOS and Linux in mac you have to satisfy with system and have stay between the boundaries that implemented by apple. But if you take Linux there were no boundaries you can explore edit everything as you like and there is more freedom, same applies to microcontrollers rather than using given set of commands I can go for more which helpful in my system. More studying still going at the time of creating this report and more information will include in future reports as well.

11.2 PCB etching

Circuit designing was a crucial part of the system to do that, some software's come in handy like Eagle CAD once we develop the design with Eagle cad then we need to print the circuit in to copper board. This whole method was called as PCB etching, which is designing, printing, finishing the PCB design. PCB designing has various approaches but in this project peroxide based chemical method was used.

PCB etching process is a chemical process which use to remove the unwanted copper from the copper board. While keeping the needed copper line in the board. Then remove the printed ink out using sandpaper. Then you get a fully printed circuit board as you design.

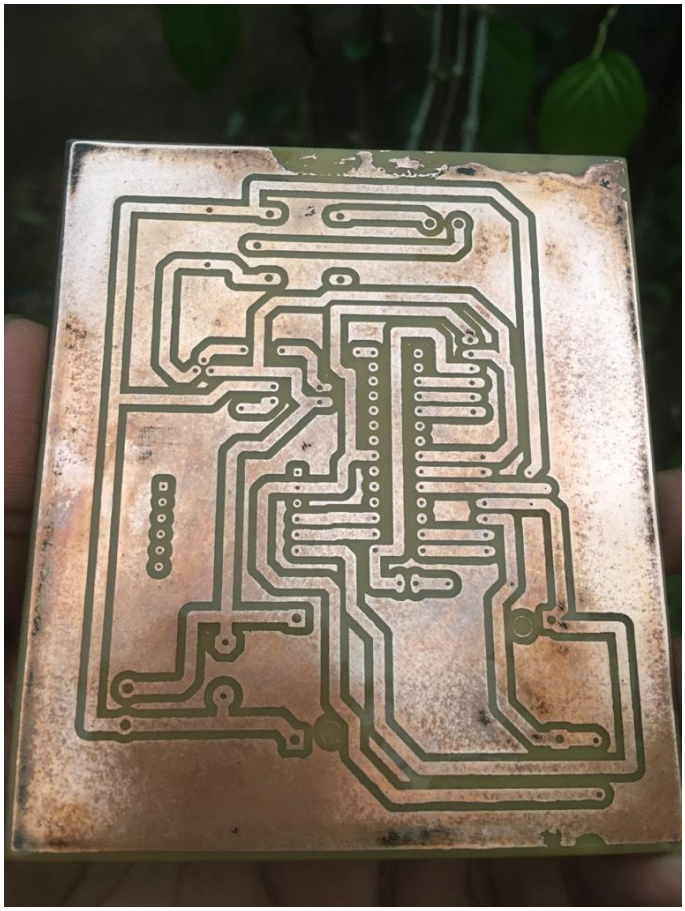

Figure 13 Final PCB

There are two ways of etching one is Chemical Etch and second method is Laser etch. Chemical etching method use "Ferric Chloride" as the chemical which used to clean away the copper which are not a part of the system. Lasers etch is a new approach this is really quick method but need some expertise knowledge and devices to complete.

Advantages of PCB etching

Main advantage is freedom of design, you can use any design as you like and design it and print it. Then using this method, we can easily etch the PCB. It takes less time to print it at home and it saves money to etch. It gives full control of the system. You can add pieces as many as you like.

Drawbacks of PCB etching

There is risk of injuries if it done by unprofessional people. Final quality will not be meet your standards if it's not correctly done. It exposes you to toxic chemicals waste which may affect your health. But regarding the health you can take precaution methods, like wear gloves and masks and glasses. Always get knowledge about the process before approach.

11.3 Eagle CAD

Eagle CAD (CAD, n.d.) is a PCB design software used in this project to design the PCB board. PCB etching was mentioned above before project comes to etching phase, we need to design a system to be print. This system was completed by Eagle software. It was developed by Autodesk company. This software provides various component to successfully print a design all connection and testing also can be performed using this software.

11.4 Proteus Software

Proteus is a software mainly use for electronic design simulation. (Proteus, n.d.) This has tons of tools to completely design and test a software. Before we print a PCB, it is a main part to test the circuit whether it perform well. This software can also use to design the PCB, but Eagle CAD has feature rich environment to work with. But when it comes testing and simulation this is the best software to choose. One of the main requirements in this project is to test the possibility of the components as this is developed for use in domestic any error may have bad effect on client. To do this we use this software and test all the components by giving the highest output and test results were recorded.

11.5 LM 2596 Buck converter

The buck convertor is mainly applied in switched mode power supply (SMPS) circuits where the DC output voltage needs to be lower than DC input voltage. As a class of SMPS, buck convertor includes at least two semiconductors such as a transistor and a diode. In the modern buck convertors, replace the diode with a second transistor for synchronous rectification and

a capacitor or inductor or as combination of both of two. Filters made of capacitors reduce voltage ripple in output of buck convertor.

Buck convertors deliver considerable power efficiency as DC-to-DC convertors. There are several applications of buck convertors such as,

- Computer's main supply voltage down to lower voltages.
- Battery chargers
- Solar charges
- Power audio amplifiers
- Brushless motor controllers

This is voltage controlling unit which helps to deliver the constant power to the GSM module when it connecting to database via a network. When module connecting with network it draws much power and it need to be delivered at that time, only after that it need to go to normal state. In order to do this, I am using this converter. Bought and tested.

DC transfer function is an equation that relates the input voltage, output voltage, and duty cycle of the buck converter.

$$Vout = Vin * D$$

Where,

V out is the output voltage.

V in is the input voltage.

D is the duty cycle, or percentage of the time that the MOSFET is turned on.

11.6 Android Studio

Android Studio is the IDE for googles development system for Android based OS. It natively has support from google. This IDE based on IntelliJ software by JetBrains. Now separate development environment based on Kotlin but still this is not invalidating because of native Java language. Emulators came built on where you can test your code on simulated environment.

11.7 Firebase Realtime Database

Firebase is the database (Figure 24 Appendix Firebase) this project use. it is a cloud hosted database. Data is stored as JSON and update continuously with connected client. Realtime database automatically receive data through REST API they have created. Instead of typical HTTP request Realtime database use synchronization when one device connected change the data all the devices that are interconnected will receive the update quickly. Firebase apps responsive even when offline. Realtime database is NoSQL database which is it has different approach to storing data like a tree method rather than typical database design.

Authentication- User authentication was an inbuilt function of the firebase as it used to register a user and login a user. there are many options in the authentication menu like email, google Facebook, integration but overall email password method was used to register a user.
Hosting – For developers hosting was provided by the Firebase and its free for some extent. API are also can be host.
Storage – Storage facility is little bit limited but can be used to develop a small project.

11.8 Postman

Postman is an API testing tool which is available for free. It saves lots of time as the users do not need to create complex HTTP requests.
It is more efficient and eliminates the repetitive complex testing tasks.
It can be used to send requests to web servers and get responses without using a web browser and that way it can be used to test API endpoints and read the response with it.
In the process of developing an API or checking an API document a need for testing endpoints arises. To this postman can be used.
It has a testing environment to create GET, POST, PUT, PATCH, DELETE requests (most CRUD operations) and send them to the RESTful API endpoint and receive responses and collect those requests and responses for future use or analysis. The request properties (types, header, parameters, method, Query params, Application types) can be entered using user friendly GUI. All these things are saved on the cloud a so it can be view and shared with anyone anywhere.
How to use – You can simply login to postman (Postman, n.d.) everyone needs to have an account created to use this service or you can simply download their client to pc. Then jut run the application. When you need to test API just put the API key. In this project postman was tested using JSON files.

11.9 ThingSpeak

ThingSpeak is open-source application and API to visualize data which was send to it. It has support from Matlab and MathWorks. Once you create an account in Thingspeak it provides you a free channel which you can use to send you data. It provides you with API key which can be used to send data. Data was sent as a POST request and GET request can be used to send data.

11.10 Atmega 328p

Atmega328p is a single chip microcontroller. (Figure 35 Appendix: Atmega 328p) It was developed by Atmel. Its processor is a modified Harvard architecture 8-bit RISC. Atmega328p is a low power consuming model of Atmega328. The “p” stands for Pico Power. It enables the controller to go down more than 1.62 V with full functionality without any errors.

11.11 Sim800l GSM module

Sim800l is cellular module. This works with 2G connection it can send and receive data SMS sending Phone calls connecting to internet are all possible. This has separate antenna which eliminate any connection issues. This is a main component of the project because this is the device which connect smart meter with its database. When smart meter records the unit consumed it was sent to GSM module. Then this module calls the JSON file of the Firebase and send the data to real-time database.

11.12 Current Sensor

Current sensor is the device used to get the consumption electricity. This is also a main component of the project. In the designed project use 5A input sensing device, this gives all the outputs until it receives 5A maximum. It is enough for our project but if we going to implement this to industry then we need to replace this sensor with the 15A sensor because CEB send electricity via 15A line. Current sensing device 50/60 Hz transformers PCB mounting device. Main wire is going through the hole and this device can sense the pulse and give the output in to the system. This includes sensing overload current ground fault detection and metering and Analog to digital circuits.

12.0 Student Learning Undertaken and Required

This application uses many technologies to complete like microcontroller coding, java, and several others, many technological methods were followed to complete the system.
Main facts that learn through this project were,

- How to create a physical circuit print ir and code microcontroller.
- How to get output from sensors.
- How to connect third party device with non-localhost database.
- How REST API works with JSON files.
- How to connect firebase with mobile app and update frequently.

Atmel studios use C++ as their main coding language. Some effort must be put in order to learn these languages and to use it in Atmel.

Printing the PCB was quite challenging have go through various learning curves to get knowledge then tested a dummy PCB and get good results, after that perform the final project and it come out as planned.
To create the mobile application first tried with some new technologies like Flutter and React but eventually found out Java is the most suitable option as it has massive support from communities like Stack-overflow and other places and it is preloaded with many libraries which can be used to develop ap further. Android IDE also support Java and implementation is easy to understand. Some of the third-party libraries have been used to improve UI UX like using material design to bring out very responsive user interface.
Started researching on the old systems that has been used in sri lanka as well as other countries. So, I eventually found out that in early 19s sri lanka used prepaid electricity system. Where coins were used to top up the system.
My knowledge in Arduino was not good so I have to start learning it. Linked learning courses are being followed to get more knowledge.
Using frameworks was always not pleasant as some frameworks are not really user friendly and not supporting my work all. So, I need to test some of them to get knowledge.
My knowledge in electricity field was not enough on some occasion where I seek help from some electrical engineers learn certain things.
My knowledge in electricity calculation was not enough so have to learn about it.

12.1 Using a SMS system

While I was doing my research, I investigate industrial level electricity usage and found out that it's not possible for a person to go to each and every company and record their electricity for that they use SMS system where this system will automatically sand an SMS to CEB with the usage of that particular premises. After I understand this, method I think it's perfect for me to use this in my project because even one system fails there is always another system to rely on to create the bill and find the usage.

When I am starting the project some of the components were tested using the Wi-Fi module because it's easy to use and can be implemented in localhost. But moving forward I need to host the site and use online databases to feed data and for those tasks I need a remote

connection which was away from the Wi-Fi. Also, I am implementing this smart meter into domestic usage so normally it's not suitable to rely on Wi-Fi all the time. So, I moved to GSM module where I can give the connectivity to smart meter via sim card. This was tested and working as it should. This SMS system were shown in the video uploaded.

Creating the bill

Most important part of this project is showing the correct amount of usage along with the bill to achieve this goal I started a research on how the electricity billing works and how it can be helpful in my project.
Normally customers must pay before purchase a service but in electricity customers pay after receiving the service like mobile network post-paid plans. In this project research I have introduce prepaid system also which will be further demonstrate later.
All the costs that happened within the electricity system need to collect as one to determine the final or total cost to be paid by the customer.
For the billing process we have planned to use only the web portal but after discussion we introduce SMS meter reading option to our meter. In this approach in a any given day SMS will be sent with used units to CEB. So, then CEB can start manually upgrade the bill as well.

Prepaid system is planned to introduce to the final project. Prepaid system basically means that user can update their meter as they like in pay to use system. So once their quota was over power line automatically disconnect. If you need to use it again you need to pay again.

Security is another main concern to ensure the quality of the product we are using encryption methods when transferring sensitive data like meter reading. Using private public keys or using more secure framework will be introduce into final outcome.

12.2 Electronic Tariff

Electrical energy is producing at large capacity which use very large amount of capital. But the service was sold to consumer for reasonable price those rates are known as tariff. Tariff is used to cover the expenses such as capital cost of equipment, running cost, salaries, other interest.

Types of tariff,

1. Simple tariff
2. Flat rate tariff
3. Block rate tariff
4. Power factor tariff
5. Three-part tariff
6. Off peak tariff

I'll discuss some of the tariff types because I am going to use some of them in my project.

Simple tariff

This type of tariff has a fixed rate, per unit. The price changed from the consumer is at the rate of per unit consumed.

Advantages:

1. This is the simplest tariff.
2. Even a simple consumer can understand it.

Disadvantages:

1. There is no differentiation between small and big consumers.
2. The cost per unit is very high.

Block rate tariff

Total energy consumed is divided into blocks for the purpose of tariff we call it block rate tariff. For example, a consumer consumes 1500 units of energy in a month. The first 'block' of 200 units may be charged at the rate of Rs.2.00 per unit, the next 'block' of 200 units may be charge at the rate of Rs.1.50 per unit and so on.

These are the main parts of tariff and hence I am developing this project for domestic usage I used Block tariff method in my project.

If the consumption is between 0-60 kWh per month the following tariffs will be applicable

Monthly Consumption (1) kWh	Unit Charge (Rs./kWh)	Fixed Charge (Rs./month)
0-30	2.50	30.00
31-60	4.85	60.00

If the consumption is above 60 kWh per month the following tariffs will be applicable (CEB, n.d.)

Monthly Consumption (¹) kWh	Unit charge (Rs/kWh)	Fixed charge (Rs/month)
0-60	7.85	N/A
61-90	10.00	90.00
91-120	27.75	480.00
121-180	32.00	480.00
>180	45.00	540.00

The implementation of a project like this which is completely new idea needs patients, dedication, self-discipline, and understanding. Therefore, as a person all those qualities were tested and followed to make this project a success.

13.0 Research Outcomes

13.1 Prepaid system.

In order to move my project to a certain level introducing of the prepaid system is under the testing while creating this report hence I will describe what are the options of prepaid system and how I am planning to implement this into meter system.

Currently sri lanka don't have prepaid billing system for electricity usage but if take a place like hostel we can really get the advantage of prepaid system because we can keep track of the usage and also, we can pay as we use system. But the only problem of this system is that CEB use block tariff system to create the bill hence there is a mandatory fixed price to be paid by all the domestic customers. If we plan to move to a prepaid system, we need to have an option how we can charge customers this fixed rate. Because fixed rate change as customer move towards the block tariff method as an example 0-60 unit has different fixed rate than 60+ unit range so when introducing prepaid system, we need a clear understanding of how we can charge the customers, or we can implement a completely new system to billing system and change it completely. These are the two main options that can be used right now.

13.2 Prepaid system for Hostels

While I am developing my project and undergo my research, I have understood that there is a really good opportunity in hostels to use a prepaid electricity control system in their premises. As an example, if take NSBM hotels there are no electricity limitations for rooms hence, they can use electricity as they like this will eventually lead to higher electricity consumption and administration has no authority over it. But by using my project we can completely control the usage of the electricity.

How can we control?

Main thing is each and every room will provide a unit with this smart meter and every room will be given a certain unit for free as an example 100 units free. When students used these 100 units then automatically their electricity will be cut off. If they want to use more electricity, then they need to pay to the administration. This payment can take in website or any other appropriate way when a student pays the bill automatically electricity will be available again. So, they need to consume their electricity very carefully and this will be very important aspect of my project. This idea is more described in detail in my research and research document will be available in my next report.

13.3 Peek into BPL possibility

One of the main research materials of my project is looking into alternative options that can be used when developing a system. BPL or broadband over powerline is a main part I am currently looking in to.

Why?

In my original project I am using a GSM module and sim to share the details of the meter with the servers but think like this as an example power cut happen to a village and every village home has this smart meter then each and every meter is trying to connect to server and report power outage same address same URL then this will create a problem in the network which will increase the traffic so eventually system will fail. But if we can use BPL method then we can completely get away from this situation. Also, if we going to use a sim then we have to pay a amount to service provider annually, by using BPL method we can completely get rif of service provider and share our data through power line as we share electricity.

But when we plan to adapt this technology7 there are some draw backs of this system. First one is we need specific adapters to send and receive data through power line. When it comes to rural areas, we can’t predict the quality of the power lines, it may have a significant fail rate

because we don't know the bandwidth and range. Even though it has this draw backs if we really research on this, we can overcome those difficulties. Now don't compare this with fibre connection or something like because this method is slower but remember we don't need huge speeds we need this technology to transfer small data like used units or power outage condition to servers only so eventually we can adapt to this but in the meantime when I am developing my project, I stick with ISP s because it's the most suitable way of connecting the client and administration. I will explain some of the advantages in this system as this will communicate through the same cable that comes electricity to your house you don't need to spend more money. This will work in most of the places because when we think about mobile signals its range is limited in rural places. Main advantage is security, communicating with power line is more secure compare with other connection methods.

14.0 End-Project Report

14.1. Product Quality

This topic mainly focusses on product quality of the final deliverable. Various software engineering requirements are checked to ensure the final outcomes quality. HCI Guidelines, software design principals. These are further described in the Appendix. Product outcome is competed as planned but as always there may be many ways to improve the ide. The important thing is the idea and work upon it to make the first product. Product was finished as planned.

- Smart Electricity meter developed and tested.
- Mobile application Developed and tested.
- Database integration complete.
- Administration control complete.

All the objectives were complete at the end of the project. Tested several times with many clients.

14.2 Changes from the PID

On the PID I was planning to use Arduino as my main core for creating the circuit but when I am continuing the project, I understand using Atmel is always a god idea because eventually I can learn something new at the end it is the main point of the final report. Beside that using Atmel and its microcontrollers reduced my cost and gives me more opportunity to code the

system were in Arduino I was limited to functions and libraries that given by Arduino itself. In Atmel I can create my own functions and libraries to code the system. When it comes to security concerns using Atmel and its microcontrollers clearly show a plus side. Because Arduino is an open-source system, and it has its own limitations but when using microcontrollers, I have more control over security, and it helps a lot in project more in-depth details will describe later in regard of security as I am still testing the product in various situation so this will complete when it comes to third or final report.
After starting the project there were many discussions over the usage of the technologies. Because this project consists of separate technologies which were going to connect with each other we need to be extra careful with the introducing ideas.

15.0 Project post-mortem

15.1. Challenges

Electricity Pulse reader change - Main part of this project is electricity pulse reader when starting of the project its planned to use industrial electricity pulse reader. To achieve this task old CEB electricity meter use but it did not perform as planned. Many tests done and outcome is it uses a technology which is different from the one we use. then we use AC current sensor which performed into the standard and output was recorded and tested correctly.

Microcontroller programming problem – Microcontroller need to code in such a way that it performs accurately for our project. Most of the libraries needed were not predesigned have to gone through hard path of learning to create some of the libraries that needed to complete the task.

PCB Design problems – I went from Arduino to Atmel studio because it has many advantages but one of the drawbacks is it's not come with predesigned boards, so all new board need to design and print. This path is little bit hassle. But after referring many articles and videos successfully completed the project.

15.2. Risks that have Materialized and Faced.

Risk	Initial Management Strategy	Materialized [Yes / No]	Response / additions to Strategies
Difficulty in learning new technologies	• Complexity will be limited.	Yes	• Use internet as my main source. • Spend time with Atmel studio. • Learn through mistakes
Schedule Overrun	• Use highlight reports to track progress. • Current plan will be altered under the supervision of the supervisor.	Yes	• Using a GitHub repo in order to track progress and version controlling. Research and gather info to help it
PCB drawing and printing	• Since changed from Arduino this risk arises and successfully completed.	Yes	• Use a printing machine and print the circuit and tested
Prepaid system required completely changed tariff system	• Go through many research and found more ways to fix it	Yes	• Control the risk with new plan to control this.
Corona Covid-19 situation	• Develop a virtual system	yes	• Completed virtually and physically
Mobile connection/signal issues	• Research ideas were used to simplify the system	yes	• More powerful unit use and completed.
Outdated technologies	• we must quickly move to better system to avoid those problems.		• Understand and learn new options and quickly adapt to those

15.1 Future implementation

This is a Project both user/customer and administration/client both uses. Because of its vast usage this need more improvements thorough out its working cycle.

Application – Application is a basic app without huge features. This can be improving further by implementing new UI UX improvements. We can use various libraries in order to make it easier for users to interact this app will use by different age range users and it must be easy to use. notification system can be implemented into the app. This app records the current usage we can add notification in a designated range where user can set up the usage limit and when that limit reach app notifies the user you reach the limit, by implement this method user has more control over the current usage. This will affect the current usage and help to reduce it.

Ap uses graph provided by Thingspeak but we can use Firebase data and BigQuery to perform this task and get an output to application as it will need money, when we use this as commercial application, we can buy this service. Online payment also a path that need improving. Currently it's just a dummy project as this is not commercial application. But we can add Sri Lankan payment methods to app can connect it with CEB to take bill payment. Bill records will also be record in the app.

Smart Meter – Smart meter was created as a Domestic meter. This can further improve to use in commercial places like factories and business places. Changes need to be done to tariff and changes need to be done to the current sensor. Now it is using small current sensor because we use only a small appliance but when we move to real life scenarios, we need more accurate sensors to record the correct data. Meter can have more improved display to show details and also bill. Solar Panel can be added to meter right now meter have battery backup if power cut happen it can keep the system work for about 12 hours.

16.0 Conclusion

Electricity is a main requirement for modern people. In Sri Lanka we still rely on the old system to calculate the electricity and every task throughout the system until you receive the bill was completely manual. In order to move with new technologies, we need to use new technologies with electricity fields. CEB itself doing some research on how to implement new technologies to make their work easier. Using new technologies save both time and money. One of the main advantages of software development is it makes peoples life easier. Like if we built smart meter, we could easily connect it with our mobile application. Which completely gives new experience to users. Making peoples life easier was a good practise that we can provide from this project. After successfully complete the project we both provide a meter and application which will be beneficial for both people and administrators. This project provided full qualification needed to software developer to pursue a career in market.

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18.0 Appendix

18.1 User Guide

- This is a both client and user application. Client will provide the Smart meter to customers customer then use it as their main meter. But as this is under the testing phase this can be use after the original meter of CEB.
- All the power usage will be recorded automatically.
- Users must download the application and install in their mobile phones.
- User the must register to application providing the Account number.
- Administrator from CEB check the smart meter and connect the smart meter with relevant user.
- After setup, your reading will live at your application.
- Bill will automatically calculate and show in the app.

18.2 PID

About Us

Word smart is now trending in everywhere on earth but when it comes to society of Sri Lanka is it really take the full advantage of smart products. My mission is turning our day to day life items into smart devices and take the best out of it. It's the main reason why I choose to develop a smart electricity meter to record the electricity usage in far more modern way. Where we can control household electricity usage without hesitation and easily.

Introduction

Smart electricity meter which we going to develop is an electric device which records electricity consumption of house or building. Main different of smart meter is it records the data digitally where our old or current systems record data in mechanical process. And this meter will constantly communicate with server or organization it developed and update with meter reading. Also, this device will communicate information to user or the customer in simplified way where they can clearly understand their usage and act upon that. Rather than waiting for whole month to see the electricity bill with this method they can plan their bill before bill physically comes to them.

How this smart electricity meter works? My system has two main part first it's the meter then user interface which I'm going to develop as a website and mobile application. In the first part meter it includes electricity pulse reader which is a sensor to identify the amount of electricity goes through meter or the consumed electricity by user. Then I connect it with my circuit where it reads that data and stored. I programmed a system using Atmel which connect gsm module, which sending the collected data to server which this account connected. In server in given intervals all the data that received is recorded. In the meter we are displaying the electricity usage just like normal electricity meter with some other information like connection status. We use gsm module with service provider to make connection through internet. In the web site we have both admin part and user part where in admin site administration can see the electricity usage of each user and their billing history. If some user does not pay the bill administration can simply disconnect the electricity until user pay the bill. In user site user can login using give credentials and they can see their usage and their bill. If administration disconnect one user in the next interval server inform it to meter and meter disconnect power to the system as this is two-way communication system, it's possible to do this task.

Business Case

Business Need

In Sri lanka we all use old typical electricity meter which provided by CEB Ceylon Electricity Board which is very normal meter which has a mechanical approach to read the usage. Now with this system we have two problems one is we always need person to read data from meter and in midst of times like now because of Covid-19 this person can't physically visit each and every house. Its not safe also. So now a problem arise, how can we record electricity usage? That's the problem I'm going to address with this advanced smart meter. The next problem is consumers need to wait until end of the month to see their usage unless they go and manually read their meter output and guess their usage, but this is far more difficult situation because there is a little bit advanced billing process used by CEB. But I'm planning to simplify this situation by providing live bill update where user can simply log in to their account and read their usage along with current bill. So eventually they can put up some boundaries to their usage.

I also see another path of business approach to my design as we have many student hostels in Sri Lanka where student use much energy. Administration, or the university have no control of it. if we can implement my system to one of the hostels then administration can control the

usage of electricity inside their hostels. So, they can put a limitation on usage of electricity to each and every student. With this approach student also get benefit where they can see their electricity usage and plan their usage till the end of the month and I administration can connect and disconnect the electricity of the hostel as they need. This is giving better control over the things that really matter.

Business Objectives

To modernize customer experience and give whole new control to client administration,

- Remove the staff need to collect and issue an annual bill.
- Gives full control to client/administration.
- Measure and update the electricity usage online.
- Notify any problems with system automatically.
- Give easy approach to access the system.
- Create an automatic billing system
- Connect and disconnect power as needed.
- Customer has better interaction with system via website or app.

Project Objectives

1. To provide and enhance the control of the system.
2. To control customer usage within the system.
3. To reduce labour and earn productivity with cost cutting mechanism.
4. To implement an easy and modern approach to the system.
5. To implement new meter with more digitalize system than old system.
6. To make the billing process automated and controlled.
7. To analyse how system will benefit both customer and client and the problems they face while using old system.

Chapter 4: Initial Scope

1. Business process along with their short comings will be identify by interviews and careful observation and documented using UML activity diagrams.

2. This proposed system will allow,

    - Customers to see the usage and automate the billing process.
    - Customers to see the left-over units if we change the approach to planned path.
    - Customers can see and report online if there is any power outage in area.
    - Administration to set a limitation to one or more accounts as need.
    - Client to issue online bill.
    - Client to connect and disconnect electricity online.

3. Client requirement will be elaborate further using interviews and information gathering.

4. Complex system changes can be implemented for different usage patterns like introducing prepaid system.

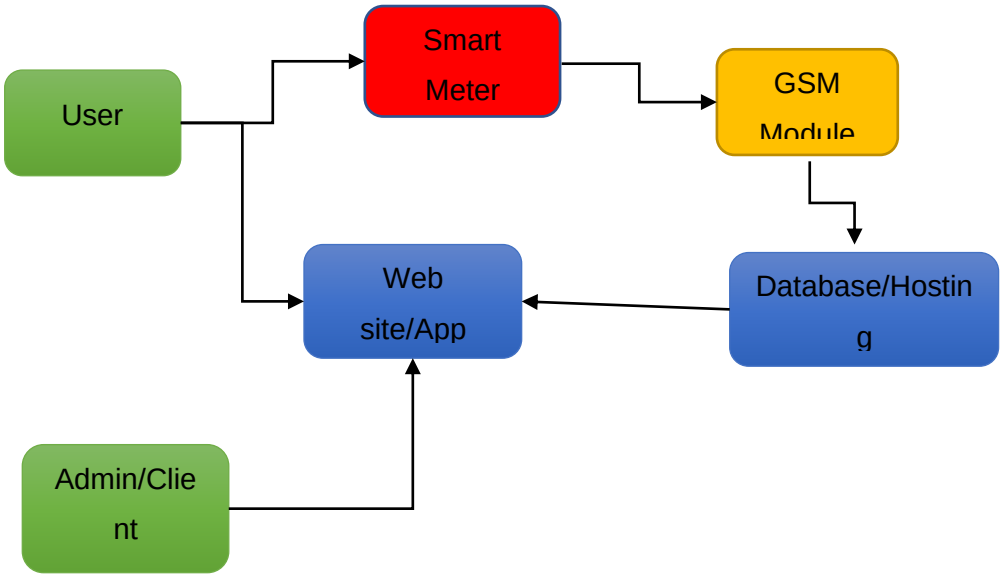
5. This system can be introduced to universities and hostels to be used within their premises for more control over electricity.

Method of Approach

Initial Scope

Product development will include two main things which are the smart meter and website/app for interactions. We focus mainly on correct readings and data collection part in meter where we design our circuit and include electrical pulse reading sensor along with other parts which are design by us. We use Atmel studio with C++ as our main coding language along with Eagle CAD for designing circuit.

Next part would be the interactions with user or customer where we plan to use an online application along with a web site which has an updating database with two separate logins for admins and customer. We plan to use AWS hosting as our hosting provider right now we considering other alternative also and final decision will be based on these findings. We use React Native and react as our application-based code where we plan to use either Firebase or MongoDB based database for interactions with the product. Full evaluation is to be made upon creating this product where our final decision will made.



Simple diagram of parts in project.

Project Plan

Control Plan

The following PRINCE2 control techniques will be employed: end-Stage reports; end-Stage review (with supervisor); fortnightly Highlight report12; risk management (see Section 0); communication plan (see Section 0), and quality plan (see Section 0).

Communication plan

In addition to ad-hoc supervisor meetings as necessary, planned review/feedback meetings will be held at the end of each stage in order to discuss the end-Stage report, the next Stage plan, and to review any technical deliverables produced during the stage. Feedback meetings will also be held following the submission of the two Interim reports.

6. Project Plan		
Stage	**Deadline**	**Product/Deliverables/Outcome**
1. Initiation	05/11	PID
2. Investigation and requirements	30/11	Analysis of the existing system evaluation of possible technologies and documented requirements
3. High level design	10/12	Designing of the circuit board and programme Architecture. Databases
4. Increment 1	11/01	Customer functionality updated with website connecting with product
5. Increment 2	15/02	Connection between system and website/app develop with user interfaces updated
6. Increment 3	25/02	User and client requirements completed with future implementation of system with business scope documented
7. System and user/client testing	05/03	Final product user testing
8. Assemble and complete final report	20/03	PRCO303 Report

Table 1 Stage 1 plan

Stage 2 Plan		
Task	**Deadline**	**Products/Deliverables/Outcome**
Analysis of existing approach to the system and business process	10/11	Documented process
Elicitation and specification of user requirements	20/11	Requirements document
Requirements validation	28/11	Client sign-off and
Evaluation of possible development technologies	05/12	Brief report discussing possible and adopted technologies, issues considered, and reasons

Table2. Stage 2 plan

Initial Risk List

7. Initial Risk List	
Risk	**Management Strategy**
Schedule overrun	Contingency has been introduced into the project plan. Highlight reports will provide a regular monitoring of schedule. An exception plan will be developed, and approved by the project supervisor, in the event of more than 1 week's slippage
Difficulty learning/using the development technologies	A very simple system prototype will be developed during Stage 2 (Investigation and requirements).
Requirements breakdown	The prototype noted above may be extended to illustrate the contentious features. The conflict can ultimately be referred to the client for further resolutions
Technology failure	The system will be deployed using standard technologies, and system backups will be taken daily

Table 3, initial Risk List

Initial Quality Plan

8. Initial quality plan	
Quality check	**Strategy**
Requirements	Requirements will be checked (within Stage 2) to ensure that they are correct, relevant (i.e., traceable to the business objectives), complete, achievable and demonstratable. Prototyping, user interviews and walkthrough will be employed.
Design validation	The design will be checked (within Stage 3) against requirements compliance, HCI guideline compliance, screen-design acceptance, DB normalisation and software design principles (e.g., cohesion, coupling)
Sub-system usability and validation	To be conducted at the end of each increment
System validation and user acceptance	To be conducted within Stage 7

Table 4, Quality Plan

18.3 First and second Interim Reports

Introduction

Changing the traditional way of electricity meters with smart meter. Project core is almost completed with electrical components are working well and tested multiple times. While creating this report there were few things that need to complete which I have described later in the report. This interim report 2 will described the progress of the project since interim report 1 and outcomes that happen during that time.

Introducing a **smart meter** system to our domestic old fashioned smart meter is my project. In this project I am planned to develop an online meter reading application online billing system online payment system and power outage showing system for customers.
For admins I am developing online power controlling on/off system, updating, and communicating with customers and a research was ongoing to implement a prepaid system to electricity meters where customers can reload their account and use electricity as they pay. This research is still going and results and knowledge that I have gathered will be discussed further in the report.
Creating a bill was planned to do online through web interface but client hopes they need old approach like solution to this, so I have introduced text messaging system to the same project. In this method my system will send a text message to both client and CEB the number of units that consumed by customer so that they have access to the information if something goes wrong. This is also another risk prevention system which is not relying on one method always when dealing with sensitive data.
Study on tariff system to calculate the bill was completed and I have planned to develop this system only for domestic usage where block tariff system is used. Security concerns were taken very seriously, and I have changed from not using Arduino and change to Atmel coding for security reasons as Arduino is open source implementing that to industry level project was not suitable, further information are discussed later in the report for more clarification.
Creating libraries for circuits are almost over and now testing the connection with software and database. Some of the researched ideas were implemented and added to the original project. The report will further discus the project in details.

TASKS UNDERTAKEN AND OUTCOME PRODUCED

Task ID	Task undertaken	Produced actual outcome	Overall Weight %
1	Implementing an automatic text message system	Completed and tested several times with 100% working	5%
2	Classes and libraries are coded and completed for circuit	Classes for all the electrical components are done	50%
3	Electrical pulse reader bought and coding to get the accurate unit of usage	Not completed under testing	5%
4	Database integration with firebase	Undergoing some changes can finish within few days from the report creating date.	5%
5	Research study on electricity system	Various knowledge gathered from research and still researching on new technology	20%
6	Application interface including all windows are completed	Need to do some changes but mostly completed.	15%

Project Scope and objectives

Project consist of two main interfaces one for customer and one for admin.

Customer web/app interface

- User login
- Consumed units.
- Active inactive status
- Admin messages
- Live bill updates

Admin web/app interface

- Option to disconnect customer power.
- Add or remove users.
- Add electricity breakdown/ service notices.
- Send SMS

Apart from that for future implementations we have options like

- Put a limit to electricity units.
- Introduce prepaid plan to customers.

But above scenarios are deviation from original plan so can be consider as future implementation of the system as well as in order to implement those options further study on the case needed.

Background and motivation

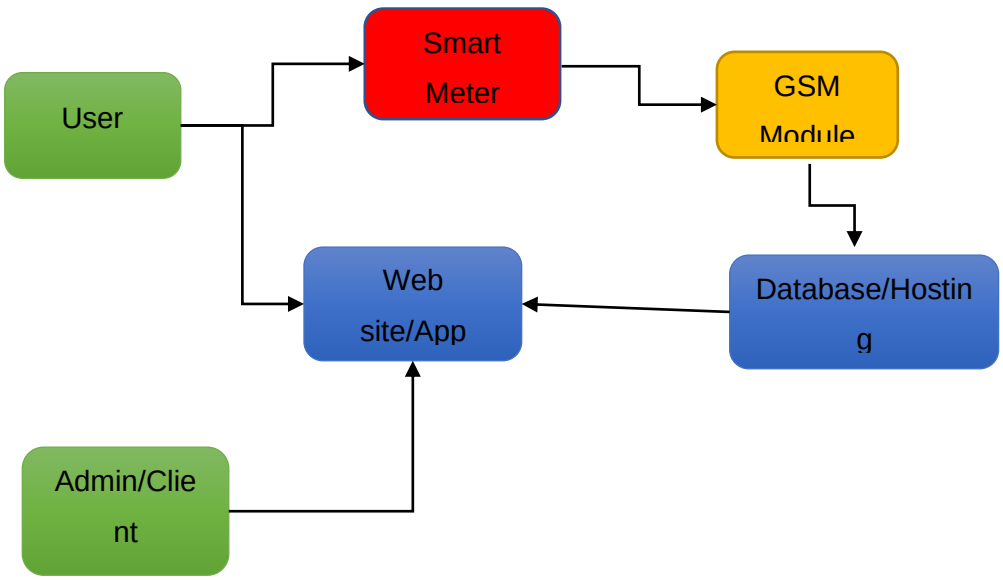
In Sri lanka we all use old typical electricity meter which provided by CEB Ceylon Electricity Board which is very normal meter which has a mechanical approach to read the usage. Now with this system we have two problems one is we always need person to read data from meter and in midst of times like now because of Covid-19 this person cannot physically visit each and every house. It is not safe also. So now a problem arise, how can we record electricity usage? That is the problem I am going to address with this advanced smart meter. The next problem is consumers need to wait until end of the month to see their usage unless they go and manually read their meter output and guess their usage, but this is far more difficult situation because there is a little bit advanced billing process used by CEB. But I am planning to simplify this situation by providing live bill update where user can simply log in to their account and read their usage along with current bill. So eventually they can put up some boundaries to their usage.

Method of Approach

Product development will include two main things which are the smart meter and website/app for interactions. We focus mainly on correct readings and data collection part in meter where we design our circuit and include electrical pulse reading sensor

along with other parts which are design by us. We use Atmel studio with C++ as our main coding language along with Eagle CAD for designing circuit.

Next part would be the interactions with user or customer where we plan to use an online application along with a web site which has an updating database with two separate logins for admins and customer. We plan to use AWS hosting as our hosting provider right now we considering other alternative also and final decision will be based on these findings. We use React Native and react as our application-based code where we plan to use either Firebase or MongoDB based database for interactions with the product. Full evaluation is to be made upon creating this product where our final decision will made.



Simple diagram of parts in project.

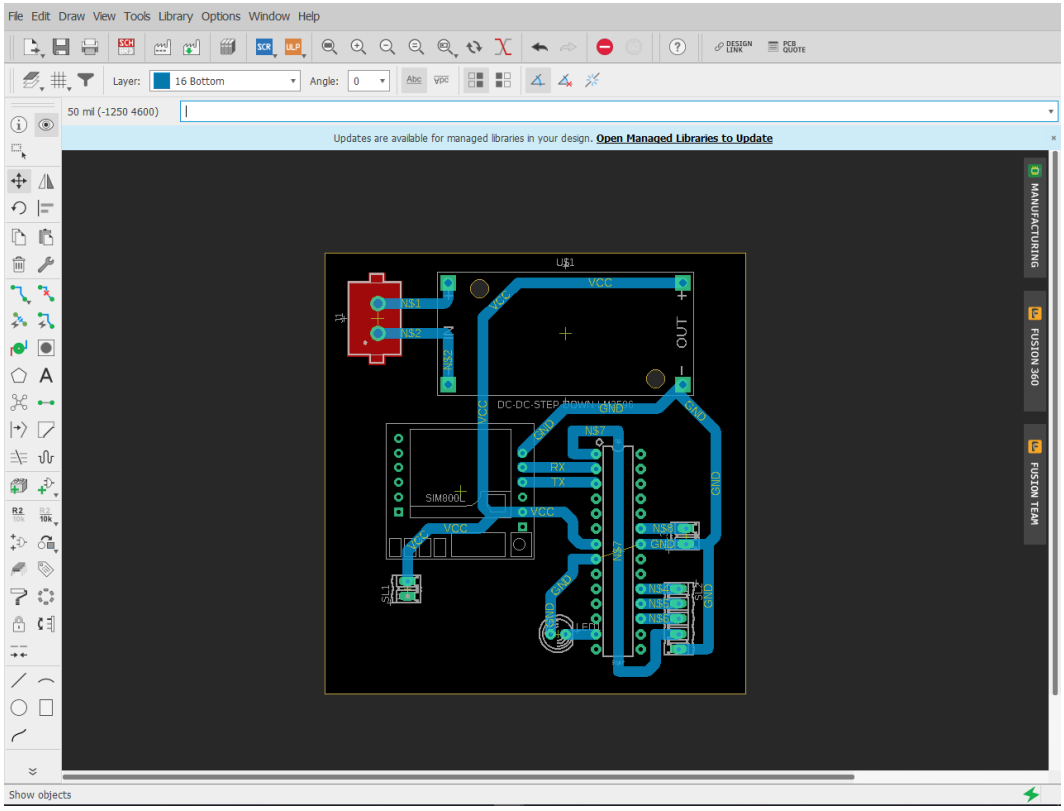
CURRENT IMPLEMENTATION

details of the products I am using, and the technologies used were described here in details. Changes that have occur between interim 1 and interim 2 were further discussed under this topic.

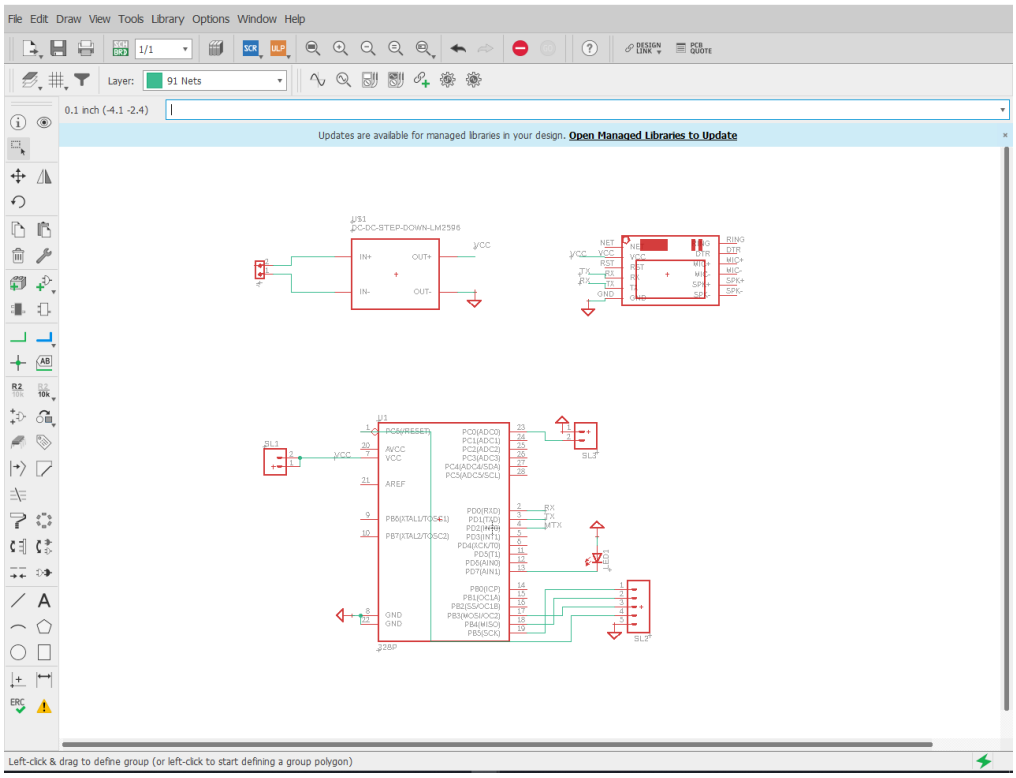
Product produced.

Designing the PCB

To create a good final product, I am designing the PCB or the circuit of the electricity meter. I used eagle cad software to design the PCB.



Connection diagram of the circuit



all the parts that connecting in the final product.

Ditching the Arduino.

On the PID I was planning to use Arduino as my main core for creating the circuit but when I am continuing the project, I understand using Atmel is always a god idea because eventually I can learn something new at the end it is the main point of the final report. Beside that using Atmel and its microcontrollers reduced my cost and gives me more opportunity to code the system were in Arduino I was limited to functions and libraries that given by Arduino itself. In Atmel I can create my own functions and libraries to code the system. When it comes to security concerns using Atmel and its microcontrollers clearly show a plus side. Because Arduino is an open-source system, and it has its own limitations but when using microcontrollers, I have more control over security, and it helps a lot in project more in-depth details will describe later in regard of security as I am still testing the product in various situation so this will definitely in the third or final report.

After starting the project there were many discussions over the usage of the technologies. Because this project consists of separate technologies which were going to connect with each other we need to be extra careful with the introducing ideas.

When it comes to app we are using React as our main language as it supports cross platform usability. We are also developing a web site for the same purpose because we want to deliver the best user-friendly version of both ends final deliverable will be took after a further

discussion and comparing the outputs ad how they function with the meter. For the back end we use Mango DB as it supports various features we expect.
We have testing Laravel framework as well as other frameworks like VueJs, Firebase for app to run and test what is the best solution.

Task Undertaken	Outcome
Creating the UI designs of the app	Use adobe XD and created designs it helps to see where need to be upgrade
Electricity unit reader bought	Main issue is this. Tried with industry meter unit reader and it works. Add to the project.
Planning on backend	Did a research on app backend and found mongo db is a good option
Connect hardware with software	Use simcom (Arduino, n.d.) module to connect two parts
User login updated	Users will not have option to register. This option moved to admins for the security reasons.
Add usage draft	Tried with TeamSpeak site and add temporary draft and further development required.

Main product will,

8. Provide and enhance the control of the system.
9. Control customer usage within the system.
10. Reduce labour and earn productivity with cost cutting mechanism.
11. To implement new meter with more digitalize system than old system.
12. To make the billing process automated and controlled.
13. To analyse how system will benefit both customer and client and the problems they face while using old system.

Project Plan

Control Plan

The following PRINCE2 control techniques will be employed: end-Stage reports; end-Stage review (with supervisor); fortnightly Highlight report12; risk management. communication plan and quality plan.

Communication plan

In addition to ad-hoc supervisor meetings as necessary, planned review/feedback meetings will be held at the end of each stage in order to discuss the end-Stage report, the next Stage plan, and to review any technical deliverables produced during the stage. Feedback meetings will also be held following the submission of the two Interim reports.

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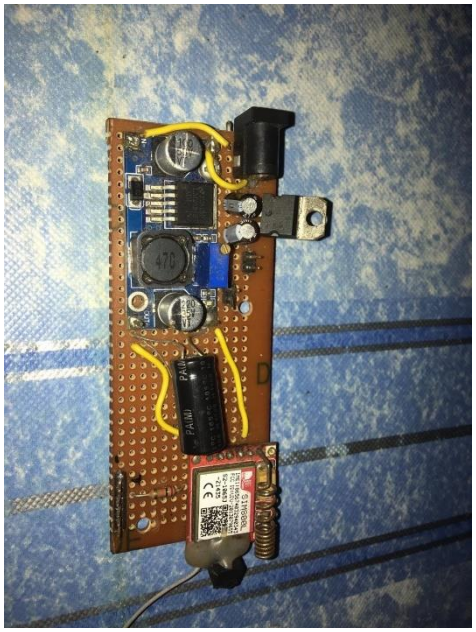
Table 1 Stage 1 plan

Progress

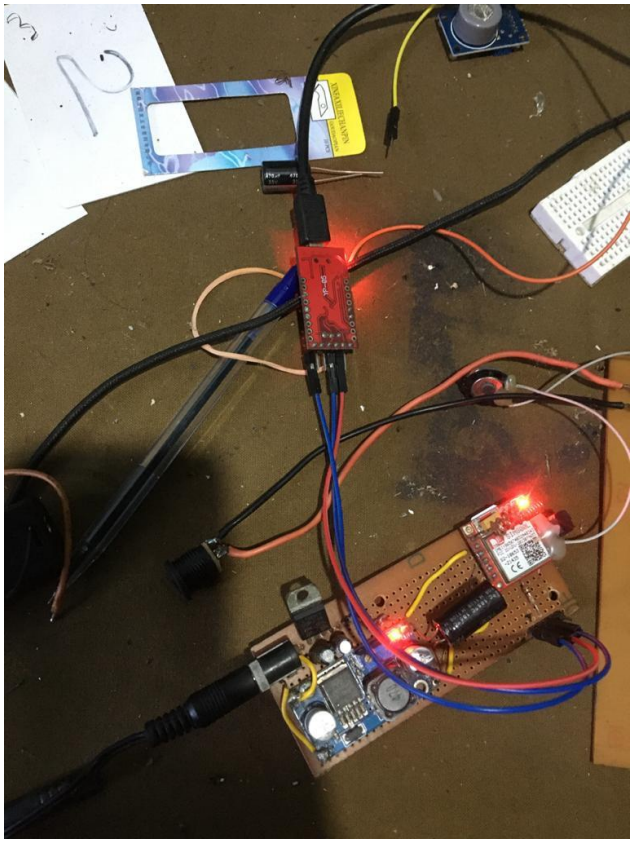
GSM module I am planning to use.
It has wider connection than the module I am currently use.



GSM module I am currently testing

Arduino uno board used to code GSM module.

Contactors use to power on and off the project.


Testing the sms system

Testing GSM module connection with backend

```
#include <SoftwareSerial.h>
#include <Wire.h>

SoftwareSerial mySerial(8, 9);            // RX, TX Pins
String apn = "dialogbb";                      //APN
String apn_u = "";                    //APN-Username
String apn_p = "";                    //APN-Password
String url = "http://localhost/new/readwrite.php";  //URL for HTTP-POST-REQUEST
String data1;   //String for the first Paramter (e.g. Sensor1)
String data2;   //String for the second Paramter (e.g. Sensor2)
int numdata=16;


const int trigPin = 4;
const int echoPin = 5;
long duration;
int distance;



void setup() {

pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
pinMode(echoPin, INPUT); // Sets the echoPin as an Input
```

```
void gsm_sendhttp() {

  mySerial.println("AT+SAPBR =1,1");
  runsl();
  delay(100);
  mySerial.println("AT+SAPBR=2,1");
  runsl();
  delay(2000);
  mySerial.println("AT+HTTPINIT");
  runsl();
  delay(100);
  mySerial.println("AT+HTTPPARA=CID,1");
  runsl();
  delay(100);
  mySerial.println("AT+HTTPPARA=URL," + url);
  runsl();
  delay(100);
  mySerial.println("AT+HTTPPARA=CONTENT,application/x-www-form-urlencoded");
  runsl();
  delay(100);
  mySerial.println("AT+HTTPDATA=192,10000");
  runsl();
  delay(100);
  mySerial.println("params=" + data1);
  runsl();
  delay(10000);

  mySerial.println("AT+HTTPACTION=1");
  runsl();
  delay(5000);
  mySerial.println("AT+HTTPREAD");
  runsl();
  delay(100);
  mySerial.println("AT+HTTPTERM");
  runsl();
}
```

```
void loop() { // run over and over

    digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  // Sets the trigPin on HIGH state for 10 micro seconds
    digitalWrite(trigPin, HIGH);
    delayMicroseconds(10);
    digitalWrite(trigPin, LOW);
  // Reads the echoPin, returns the sound wave travel time in microseconds
    duration = pulseIn(echoPin, HIGH);
    // Calculating the distance
    distance= duration*0.034/2;

    String data=String(distance);
    gsm_sendhttp(); //Start the GSM-Modul and start the transmisson
    delay(10000); //Wait one minute

}
```

```
// Open serial communications and wait for port to open:
Serial.begin(9600);
// set the data rate for the SoftwareSerial port
mySerial.begin(9600);
//delay(10000);
  mySerial.println("AT");
runsl();//Print GSM Status an the Serial Output;
delay(4000);
mySerial.println("AT+SAPBR=3,1,Contype,GPRS");
runsl();
delay(100);
mySerial.println("AT+SAPBR=3,1,APN," + apn);
runsl();
delay(100);
mySerial.println("AT+SAPBR=3,1,USER," + apn_u);
runsl();
delay(100);
mySerial.println("AT+SAPBR=3,1,PWD," + apn_p);
```

```
//Print GSM Status
void runsl() {
  while (mySerial.available()) {
    Serial.write(mySerial.read());
  }

}
```

Nuvotem Talema AC-1, Current Transformer, 30A Input

Current sensing device 50/60 Hz transformers PCB mounting device. Main wire is going through the hole and this device can sense the pulse and give the output in to the system. This includes sensing overload current ground fault detection and metering and analog to digital circuits. (Anon., n.d.)

SCT-013-030 Non-invasive 30A AC Current Sensor

Currently testing these two sensors to get the accurate reading. Testing is almost over when creating this report test results will be added in next report with the final decision.

LM25-96 buck converter

Why use a buck converter?
This is voltage controlling unit which helps to deliver the constant power to the GSM module when it connecting to database via a network. When module connecting with network it draws much power and it need to be delivered at that particular time only after that it need to go to normal state. In order to do this, I am using this converter. Bought and tested. Works fine.

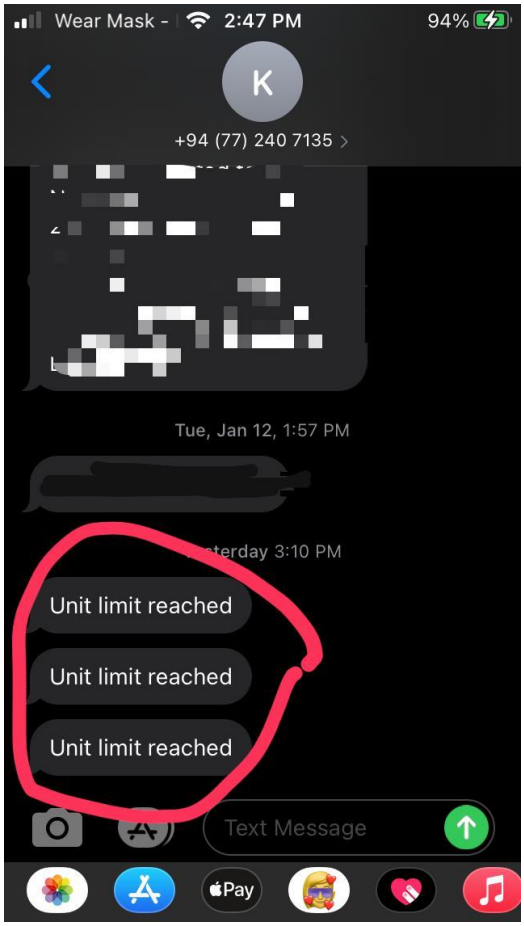
Eagle CAD

Starting to learn something by creating my own circuit is impressive. When I am ditching Arduino from the core of my project (I use it in some parts) I need a mechanism to print my own circuit or simply PCB design. I completed this task by using Eagle Cad software. Screenshots of the designed PCB was shown above in the report.

Testing with Wi-Fi module but switching to GSM module.

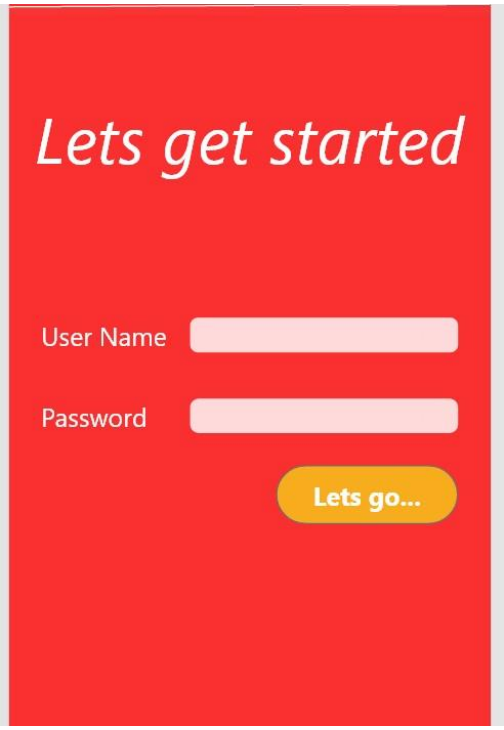
When I am starting the project some of the components were tested using the Wi-Fi module because its easy to use and can be implemented in localhost. But moving forward I need to host the site and use online databases to feed data and for those tasks I need a remote connection which was away from the Wi-Fi. Also, I am implementing this smart meter into

domestic usage so normally its not suitable to rely on Wi-Fi all the time. So, I moved to GSM module where I can give the connectivity to smart meter via sim card. This was tested and working as it should. This SMS system were shown in the video uploaded.



Creating the website/app

In order to give the access to customers and administration separate pages needed in order to do this application was still developing and in final touches how the application works, and other details were elaborated on the video.



Creating the bill

Most important part of this project is showing the correct amount of usage along with the bill to achieve this goal I started a research on how the electricity billing works and how it can be helpful in my project.

Normally customers have to pay before purchase a service but in electricity customers pay after receiving the service like mobile network postpaid plans. In this project research I have introduce prepaid system also which will be further demonstrate later.

All the costs that happened within the electricity system need to collected as one to determine the final or total cost to be paid by the customer.

For the billing process we have planned to use only the web portal but after discussion we introduce SMS meter reading option to our meter. In this approach in a any given day SMS will be sent with used units to CEB. So then CEB can start manually upgrade the bill as well.

Prepaid system is planned to introduce to the final project. Prepaid system basically means that user can update their meter as they like in pay to use system. So once their quota was over power line automatically disconnect. If you need to use it again you need to pay again.

Security is another main concern to ensure the quality of the product we are using encryption methods when transferring sensitive data like meter reading. Using private public keys or using more secure framework will be introduce into final outcome.

Tariff

Electrical energy is producing at large capacity which use very large amount of capital. But the service was sold to consumer for reasonable price those rates are known as tariff. Tariff is used to cover the expenses such as capital cost of equipment, running cost, salaries, other interest.

Types of tariff,

1. Simple tariff
2. Flat rate tariff
3. Block rate tariff
4. Power factor tariff
5. Three-part tariff
6. Off peak tariff

I'll discuss some of the tariff types because I am going to use some of them in my project.
Simple tariff

This type of tariff has a fixed rate, per unit. The price changed from the consumer is at the rate of per unit consumed.

Advantages:
1. This is the simplest tariff.
2. Even a simple consumer can understand it.

Disadvantages:
1. There is no differentiation between small and big consumers.
2. The cost per unit is very high.

Block rate tariff

Total energy consumed is divided into blocks for the purpose of tariff we call it block rate tariff

For example, a consumer consumes 1500 units of energy in a month. The first 'block' of 200 units may be charged at the rate of Rs.2.00 per unit, the next 'block' of 200 units may be charge at the rate of Rs.1.50 per unit and so on.

These are the main parts of tariff and hence I am developing this project for domestic usage I used Block tariff method in my project.

If the consumption is between 0-60 kWh per month the following tariffs will be applicable

Monthly Consumption (1) kWh	Unit Charge (Rs./kWh)	Fixed Charge (Rs./month)
0-30	2.50	30.00
31-60	4.85	60.00

If the consumption is above 60 kWh per month the following tariffs will be applicable (CEB, n.d.)

Monthly Consumption (1) kWh	Unit charge (Rs/kWh)	Fixed charge (Rs/month)
0-60	7.85	N/A
61-90	10.00	90.00
91-120	27.75	480.00
121-180	32.00	480.00
>180	45.00	540.00

Research outcomes

Prepaid system.

In order to move my project to a certain level introducing of the prepaid system is under the testing while creating this report hence I will describe what are the options of prepaid system and how I am planning to implement this into meter system.

Currently sri lanka don't have prepaid billing system for electricity usage but if take a place like hostel we can really get the advantage of prepaid system because we can keep track of the usage and also, we can pay as we use system. But the only problem of this system is that

CEB use block tariff system to create the bill hence there is a mandatory fixed price to be paid by all the domestic customers. If we plan to move to a prepaid system, we need to have an option how we can charge customers this fixed rate. Because fixed rate change as customer move towards the block tariff method as an example 0-60 unit has different fixed rate than 60-+ unit range so when introducing prepaid system, we need a clear understanding of how we can charge the customers, or we can implement a completely new system to billing system and change it completely. These are the two main options that can be used right now.

Prepaid system for Hostels

While I am developing my project and undergo my research, I have understood that there is a really good opportunity in hostels to use a prepaid electricity control system in their premises. As an example, if take NSBM hotels there are no electricity limitations for rooms hence, they can use electricity as they like this will eventually lead to higher electricity consumption and administration has no authority over it. But by using my project we can completely control the usage of the electricity.

How can we control?

Main thing is each and every room will provide a unit with this smart meter and every room will be given a certain unit for free as an example 100 units free. When students used these 100 units then automatically their electricity will be cut off. If they want to use more electricity, then they need to pay to the administration. This payment can take in website or any other appropriate way when a student pay the bill automatically electricity will be available again. So, they need to consume their electricity very carefully and this will be very important aspect of my project. This idea is more described in detail in my research and research document will be available in my next report.

Peek into BPL possibility

One of the main research materials of my project is looking into alternative options that can be used when developing a system. BPL or broadband over powerline is a main part I am currently looking in to.

Why?

In my original project I am using a GSM module and sim to share the details of the meter with the servers but think like this as an example power cut happen to a village and every village home has this smart meter then each and every meter is trying to connect to server and report power outage same address same URL then this will create a problem in the network which

will increase the traffic so eventually system will fail. But if we can use BPL method then we can completely get away from this situation. Also, if we going to use a sim then we have to pay a amount to service provider annually, by using BPL method we can completely get rif of service provider and share our data through power line as we share electricity.

But when we plan to adapt this technology7 there are some draw backs of this system. First one is we need specific adapters to send and receive data through power line. When it comes to rural areas, we can't predict the quality of the power lines, it may have a significant fail rate because we don't know the bandwidth and range. Even though it has this draw backs if we really research on this, we can overcome those difficulties. Now don't compare this with fibre connection or something like because this method is slower but remember we don't need huge speeds we need this technology to transfer small data like used units or power outage condition to servers only so eventually we can adapt to this but in the meantime when I am developing my project, I stick with ISP s because it's the most suitable way of connecting the client and administration. I will explain some of the advantages in this system as this will communicate through the same cable that comes electricity to your house you don't need to spend more money. This will work in most of the places because when we think about mobile signals its range is limited in rural places. Main advantage is security, communicating with power line is more secure compare with other connection methods.

Testing and results

Test Case Name	**Test case Step**	**Action**	**Test Data**	**Expected Result**	**Test Result**	**Note**
SMS mechanism	1	Get the meter reading	-	Took meter reading	Reading captured	Success
Send a SMS	2	Connect to SP	-	SMS sent	Receive SMS successfully	Success
Accurate meter reading	1	Calculate the unit reading	-	Collect meter reading	Read the accurate reading	Success
Start gprs in module	1	Start gprs	-			Success
Sending data to database	2	Send data over gprs	-	Data sent to database	Data received at database	success

Show the meter reading in display	1	Show the reading	-	Show the reading	Results displayed	Success but need more improvement
Display data in app	1	Display meter reading	-	Update web app	Errors occurred	Fail need to fix.

Creating libraries in Atmel and complete PCB coding

Test Case Name	Test case Step	Action	Test Data	Expected Result	Test Result	Note
Communication with lcd control	1	Display the output	##ifndef I2C_H_ #define I2C_H_ #include "I2C.h"	Define library and use it in main file	Connection works	Success
Get meter reading	1	Read the output	char tempnum[20]={0}; uint32_t hreading; void InitADC()	Show meter reading	Permission Granted	Success

This is only a sample of tested libraries that I used in the project more description of the code will discuss later.

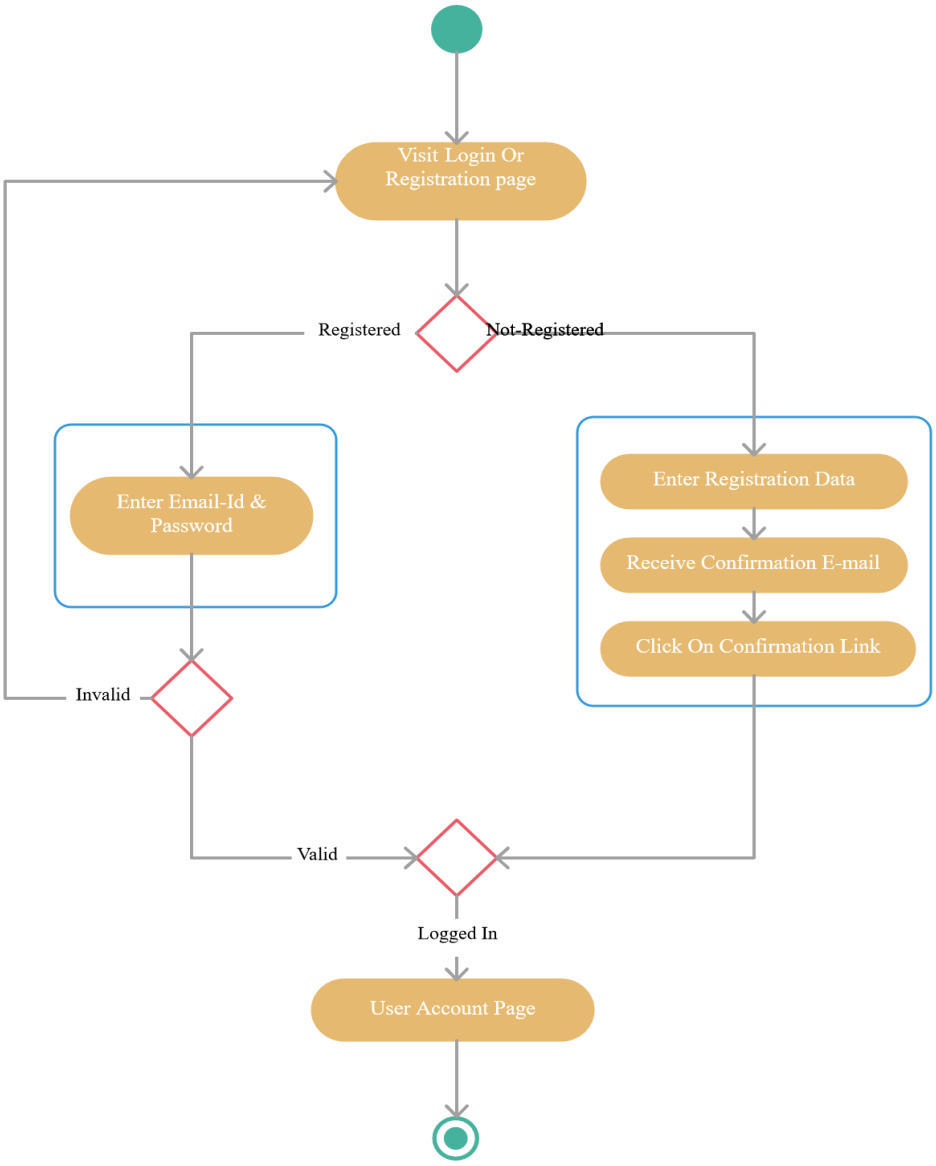
Smart meter version history

Changelog

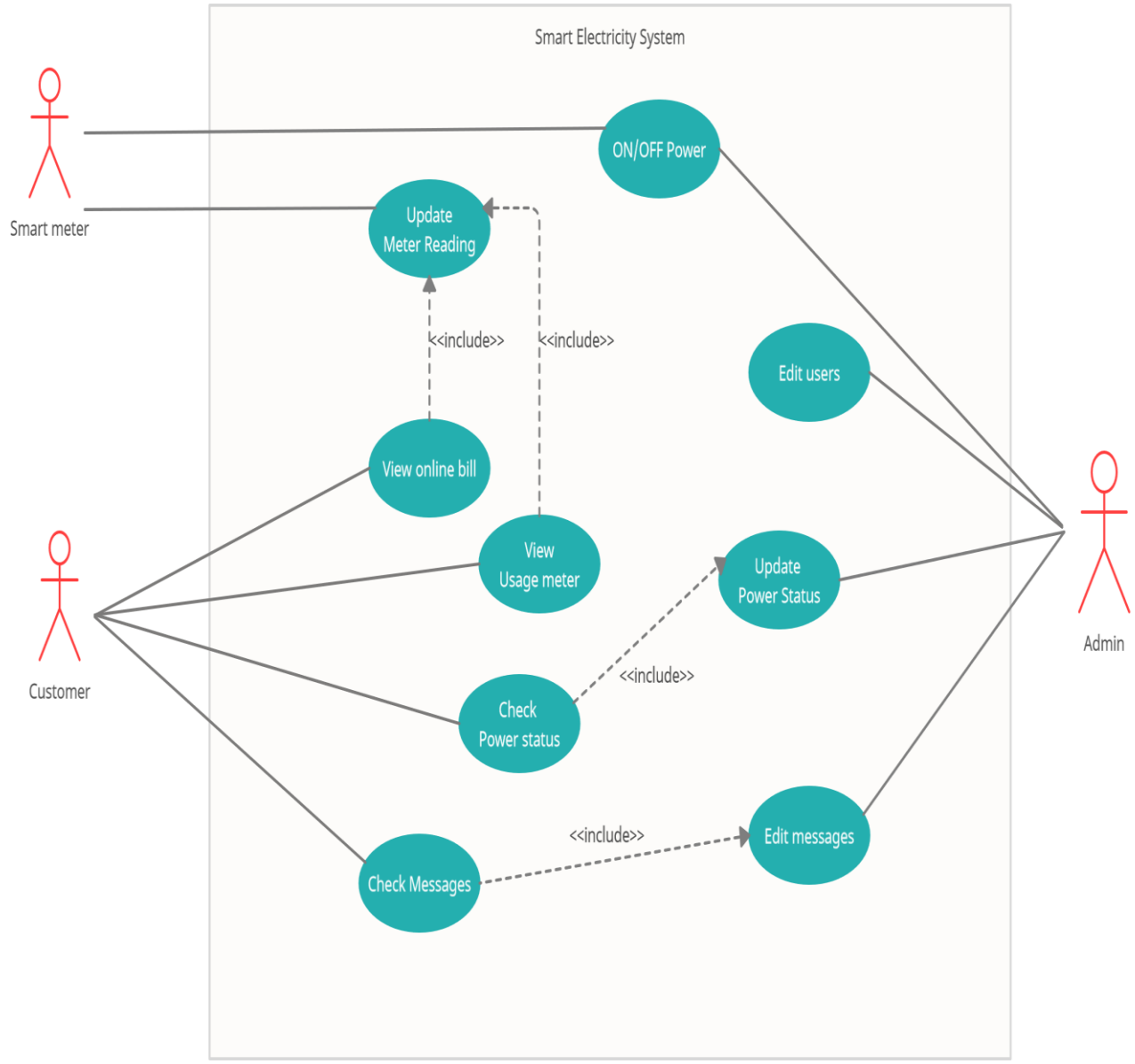
Changes done to get correct meter reading.
Meter reading connection with display completed.
Data send thorough text message tested and finished.
Database connection still testing.
UI/Ux developing in the final stage need more improvements.

Project Diagrams

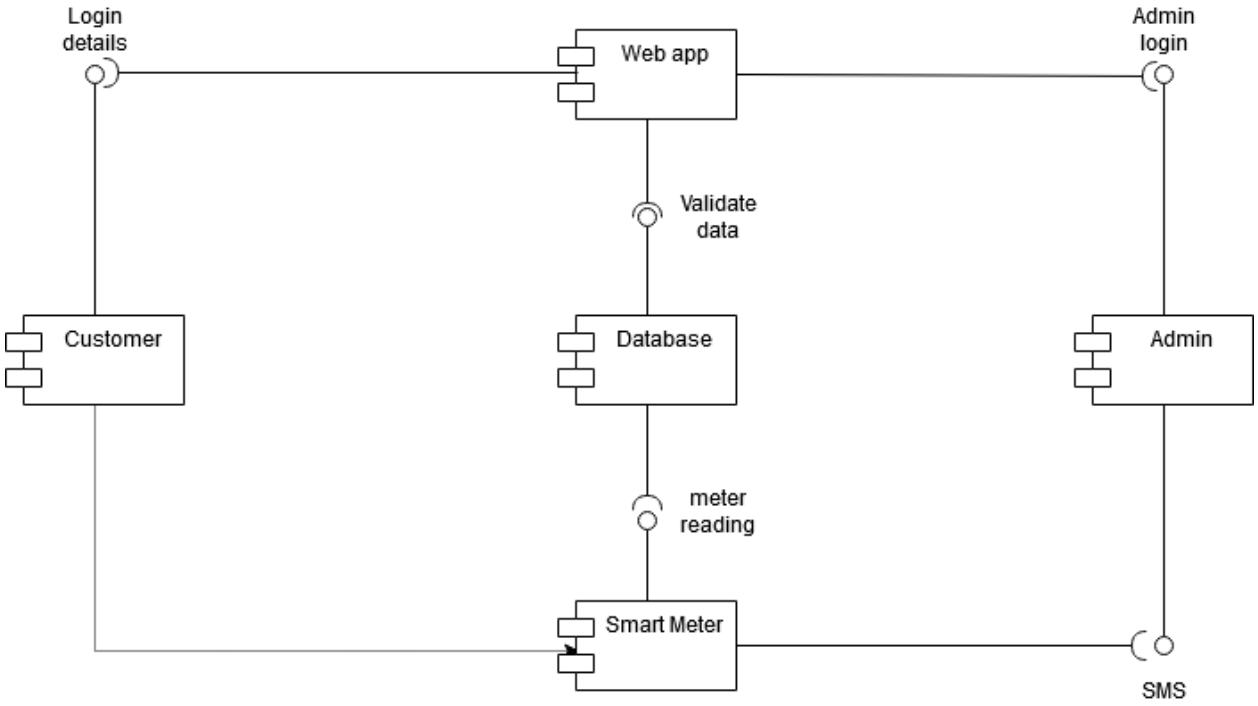
Login page Activity diagram



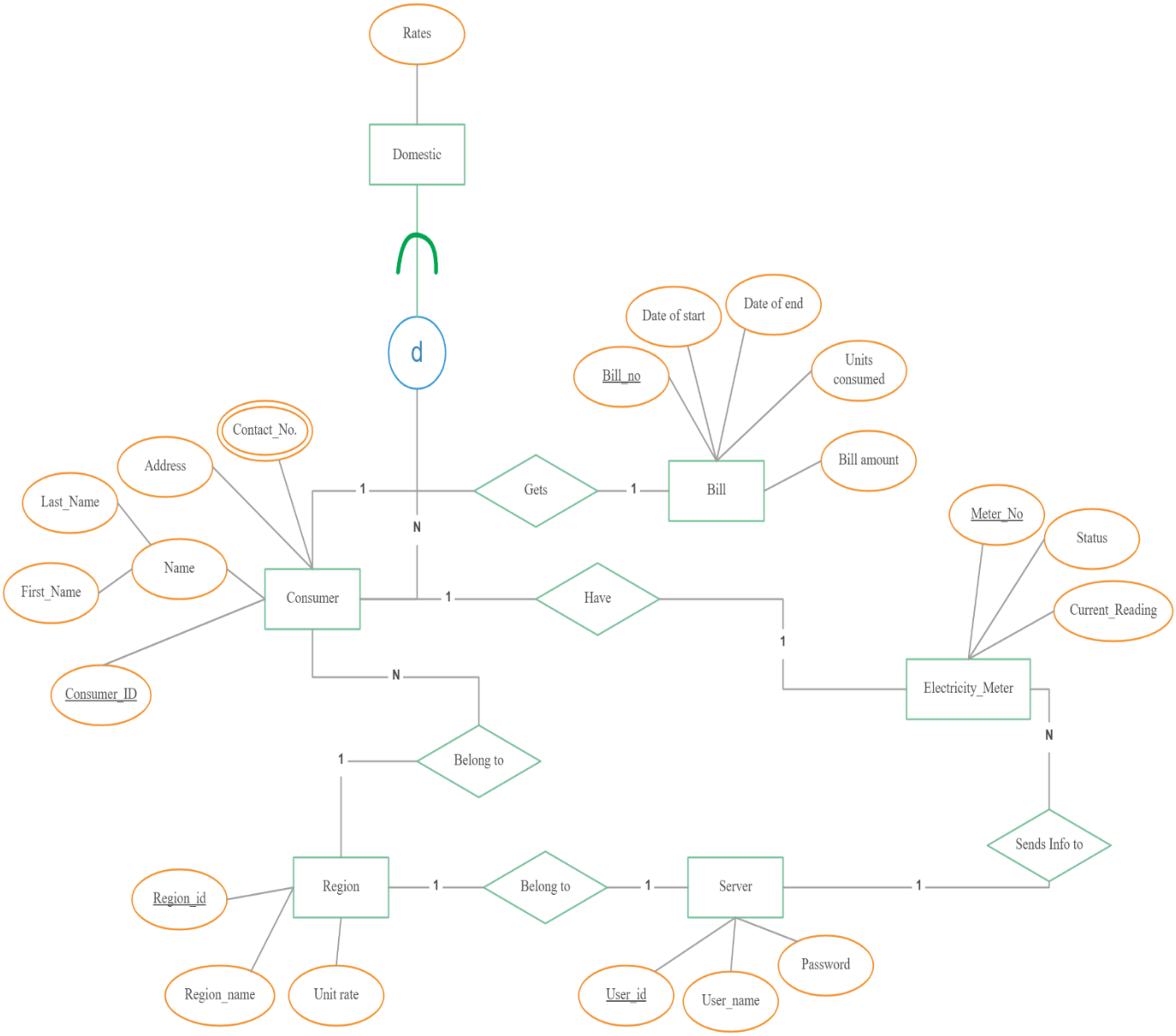
User case Diagram for the system



Component Diagram of the system



Smart electricity meter ER diagram



Project plan

Schedule

6. Schedule		
Stage	**Deadline**	**Product/Deliverables/Outcome**
1. Initiation	05/11	PID
2. Investigation and requirements	30/11	Analysis of the existing system evaluation of possible technologies and documented requirements
3. High level design	10/12	Designing of the circuit board and programme Architecture. Databases
4. Increment 1	11/01	Customer functionality updated with website connecting with product
5. Back end front end connection	15/02	Connection between system and website/app develop with user interfaces updated
6. UI UX fixing and bug fixing	25/02	User and client requirements completed with future implementation of system with business scope documented
7. System and user/client testing	05/03	Final product user testing
8. Assemble and complete final report	20/03	PRCO303 Report and project

Quality Plan

8. Initial quality plan	
Quality check	**Strategy**
Requirements	Requirements will be checked (within Stage 2) to ensure that they are correct, relevant (i.e., traceable to the business objectives), complete, achievable and demonstratable. Prototyping, user interviews and walkthrough will be employed.
Design validation	The design will be checked (within Stage 3) against requirements compliance, HCI guideline compliance, screen-design acceptance, DB normalisation and software design principles (e.g., cohesion, coupling)
Sub-system usability and validation	To be conducted at the end of each increment
System validation and user acceptance	To be conducted within Stage 7

RISKS THAT HAVE MATERIALIZED AND FACED

Since the start of project and interim 1, new Risks have not occurred. Understanding the risks plan and act before helpful in many times. Some other risks are described here.

Risk	**Initial Management Strategy**	**Materialized [Yes / No]**	**Response / additions to Strategies**
Difficulty in learning new technologies	• Complexity will be limited.	Yes	• Use internet as my main source. • Spend time with Atmel studio. • Learn through mistakes

Schedule Overrun	• Use highlight reports to track progress. • Current plan will be altered under the supervision of the supervisor.	Yes	• Using a GitHub repo in order to track progress and version controlling. Research and gather info to help it
PCB drawing and printing	• Since changed from Arduino this risk arises and successfully completed.	Yes	• Use a printing machine and print the circuit and tested
Prepaid system required completely changed tariff system	• Go through many research and found more ways to fix it	Yes	• Control the risk with new plan to control this.
Corona Covid-19 situation	• Develop a virtual system	yes	• Completed virtually and physically
Mobile connection/signal issues	• Research ideas were used to simplify the system	yes	• More powerful unit use and completed.
Outdated technologies	• we must quickly move to better system to avoid those problems.		• Understand and learn new options and quickly adapt to those

Resources

Atmel studio IDE

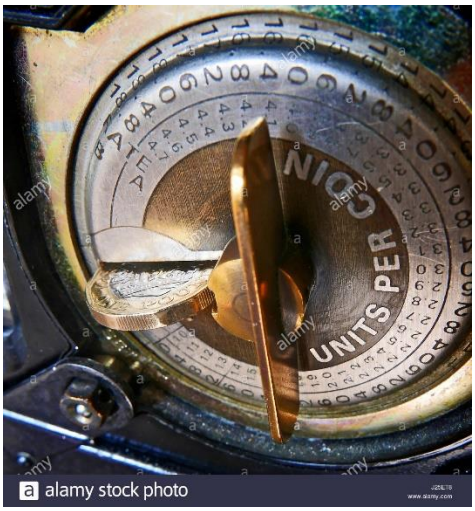
Create the PCB Atmel studio used in many time codes mainly using C / C++ since ditching the Arduino from the core all the coding must done manually more time spent in creating some libraries as there were not to be found even in internet. Must do lot of work related to this. Continues testing must be done to make sure everything performs well. Atmel studio and its advantages against Arduino were discussed earlier but more than that when comparing with Arduino it gives us a certain limitation on microcontrollers and we can't explore more than that its like MacOS and Linux in mac you have to satisfy with system and have stay between the boundaries that implemented by apple. But if you take Linux there were no boundaries you can explore edit everything as you like and there is more freedom, same applies to microcontrollers rather than using given set of commands I can go for more which helpful in my system. More studying still going at the time of creating this report and more information will include in future reports as well.

Application / database and UI/UX

Adobe XD use to create my design to reality it helps a lot when creating the app interface and see the problems between them, before I physically going to create them. Server need database connection where I tested many options and chose to stay with firebase for the rest of the project as it is free for certain limit and I can perform well in that limitation. Also, it's really helpful in sending and receiving data from firebase to microcontroller. Site is on localhost right now, but it will soon move to a good server and host there were it will work after that. Studying must be done on which technology or service provider I am going to choose.

Student learning undertaken and required.

Started researching on the old systems that has been used in sri lanka as well as other countries. So, I eventually found out that in early 19s sri lanka used prepaid electricity system. Where coins were used to top up the system.



This is a similar system used in sri lanka.

My knowledge in Arduino was not good so I have to start learning it. Linked learning courses are being followed to get more knowledge.
Using frameworks was always not pleasant as some frameworks are not really user friendly and not supporting my work all. So, I need to test some of them to get knowledge.
My knowledge in electricity field was not enough on some occasion where I seek help from some electrical engineers learn certain things.
My knowledge in electricity calculation was not enough so have to learn about it.

Using libraries.

As described in the above topic have to spend many ours with ide and creating libraries and testing them many online courses were followed to complete this.

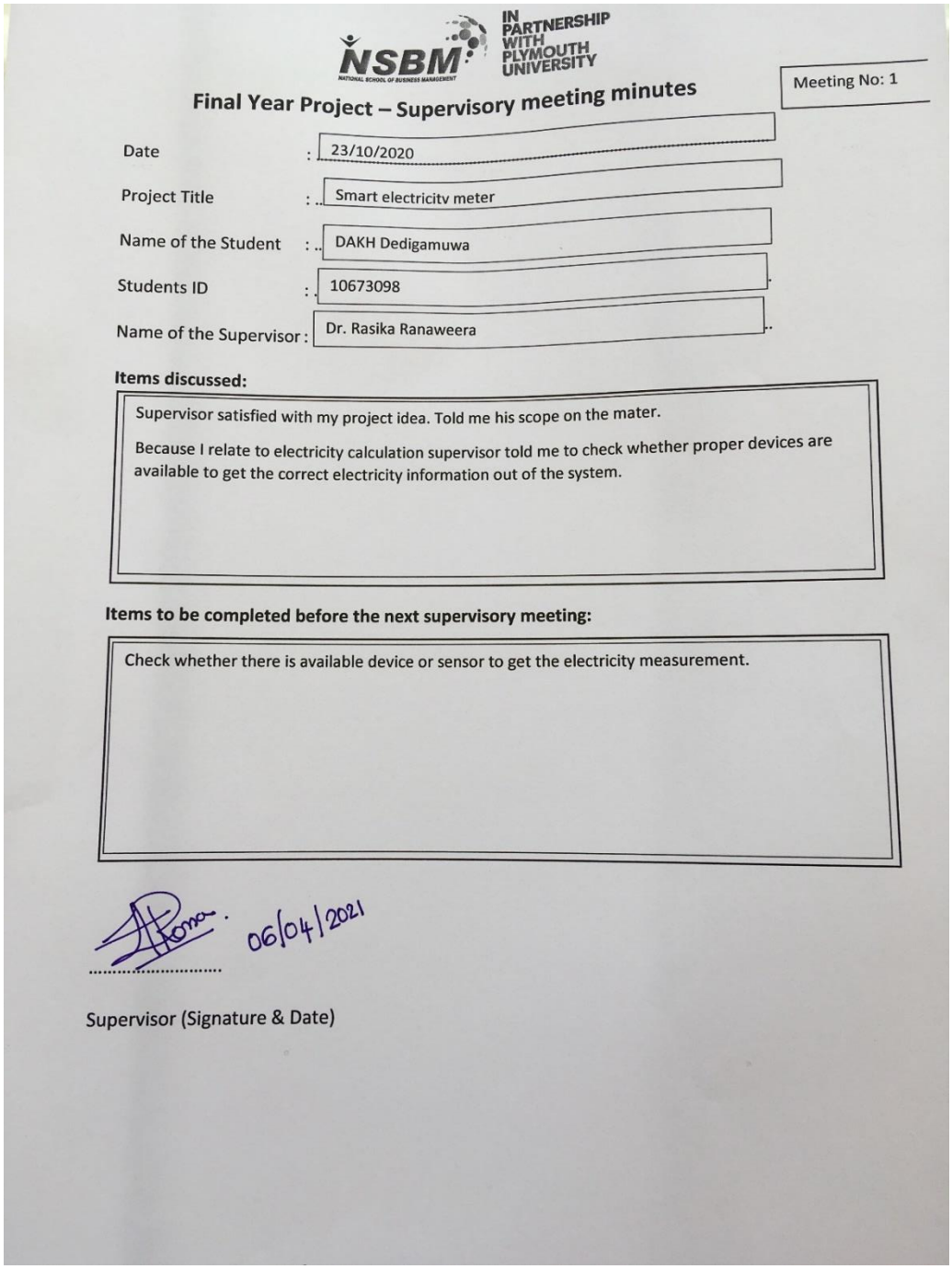
Using a SMS system

While I was doing my research, I look into industrial level electricity usage and found out that its not possible for a person to go to each and every company and record their electricity for that they use SMS system where this system will automatically sand an sms to CEB with the usage of that particular premises. After I understand this ,ethod I think its perfect for me to use this in my project because even one system fail there is always another system to rely on to create the bill and find the usage.

Introducing Prepaid system

This is also another thing I understand while I doing my research that I can implement this to a prepaid system or simply use this in hostel or similar place. My first idea was to use a prepaid card like an ATM card and top-up it and then use it to top up the meter, but when it comes to tariff system some things need to be changed in order to use that and more research was doing to find ways to implement the best possible way to create this system.

18.4 Records of Supervisory Meeting



NSBM NATIONAL SCHOOL OF BUSINESS MANAGEMENT
IN PARTNERSHIP WITH PLYMOUTH UNIVERSITY

Final Year Project – Supervisory meeting minutes

Meeting No: 1

Date : 23/10/2020

Project Title : Smart electricity meter

Name of the Student : DAKH Dedigamuwa

Students ID : 10673098

Name of the Supervisor : Dr. Rasika Ranaweera

Items discussed:

Supervisor satisfied with my project idea. Told me his scope on the mater.

Because I relate to electricity calculation supervisor told me to check whether proper devices are available to get the correct electricity information out of the system.

Items to be completed before the next supervisory meeting:

Check whether there is available device or sensor to get the electricity measurement.

06/04/2021

Supervisor (Signature & Date)

Figure 14 Meeting Minutes 1. Supervisor Meeting 23/10/2020

NSBM NATIONAL SCHOOL OF BUSINESS MANAGEMENT
IN PARTNERSHIP WITH PLYMOUTH UNIVERSITY

Final Year Project – Supervisory meeting minutes

Meeting No: 2

Date : 30/10/2020

Project Title : Smart electricity meter

Name of the Student : DAKH Dedigamuwa

Students ID : 10673098

Name of the Supervisor : Dr. Rasika Ranaweera

Items discussed:

More detail introduction of the system

Information gathered so far were discussed with the supervisor, inform him that I was able to communicate with CEB engineer where he advised me and show me the sensors that need to collect correct electricity data.

I was able to purchase the electronic equipment's but with the prevailing situation in the country Dr. Rasika advise me to act very carefully when going out to by items and stay inside and develop prototype for the system and later buy the items need to complete.

Items to be completed before the next supervisory meeting:

Designing the prototype system.

06/04/2021

.....

Supervisor (Signature & Date)

Figure 15 Meeting Minutes 2. Supervisor Meeting 30/10/2020

18.5 Anonymous Public survey

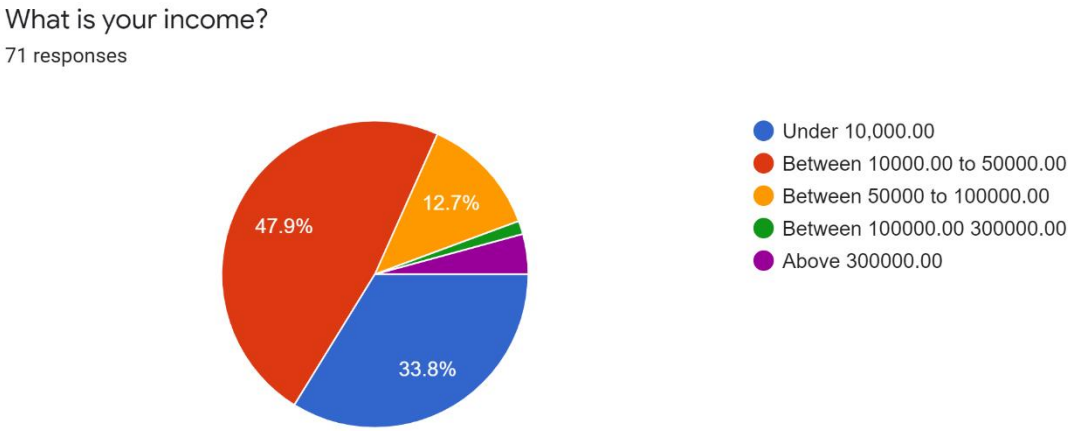


Figure 16 Public Survey 1

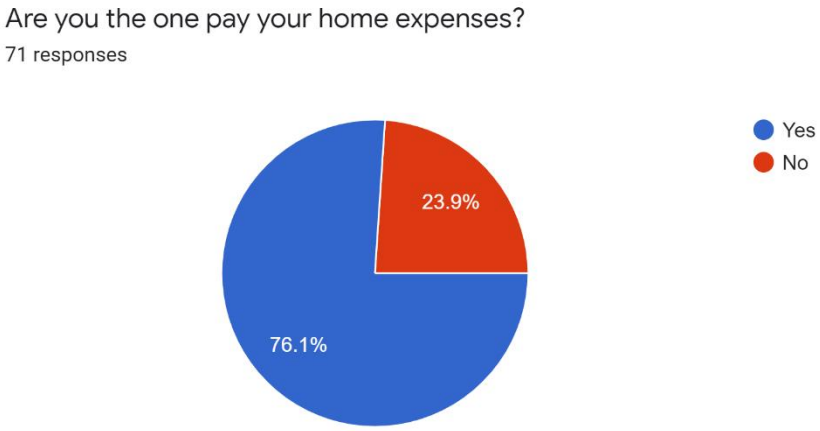


Figure 17 Public Survey 2

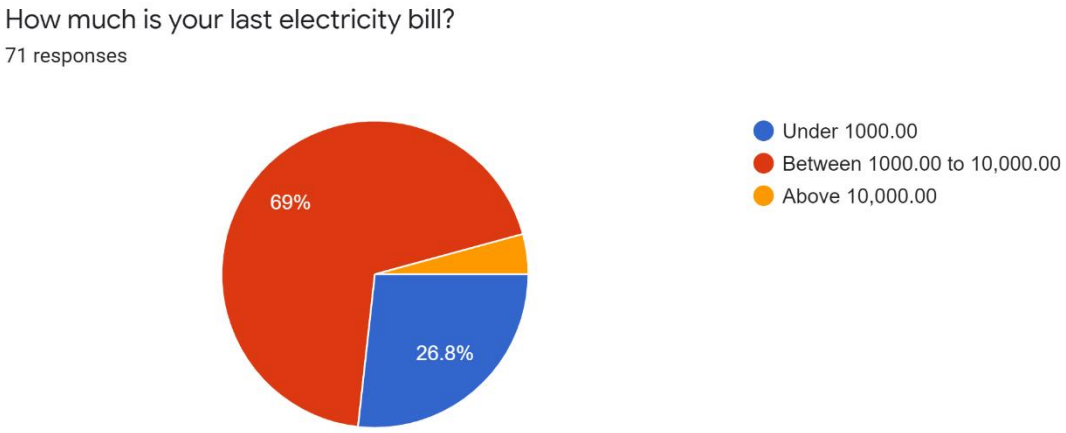


Figure 20 Public Survey 3

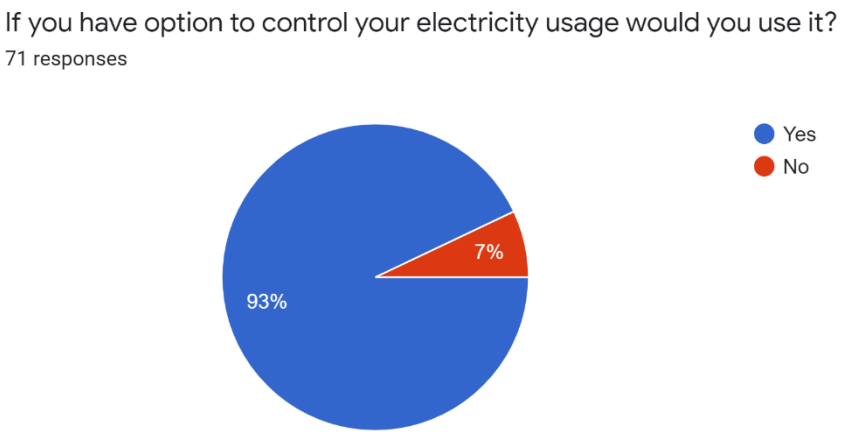


Figure 18 Public Survey 4

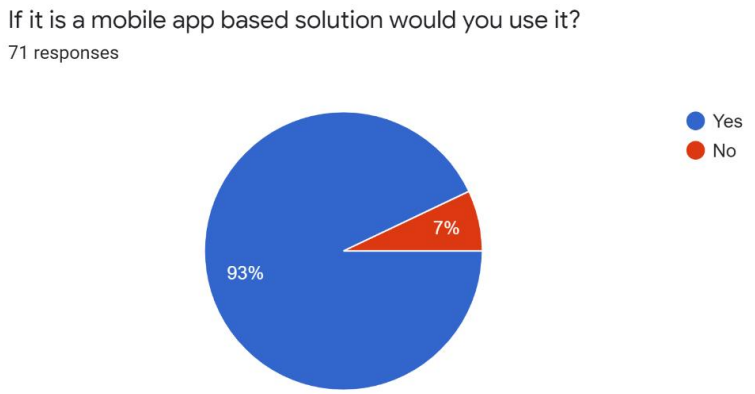


Figure 21 Public Survey 5

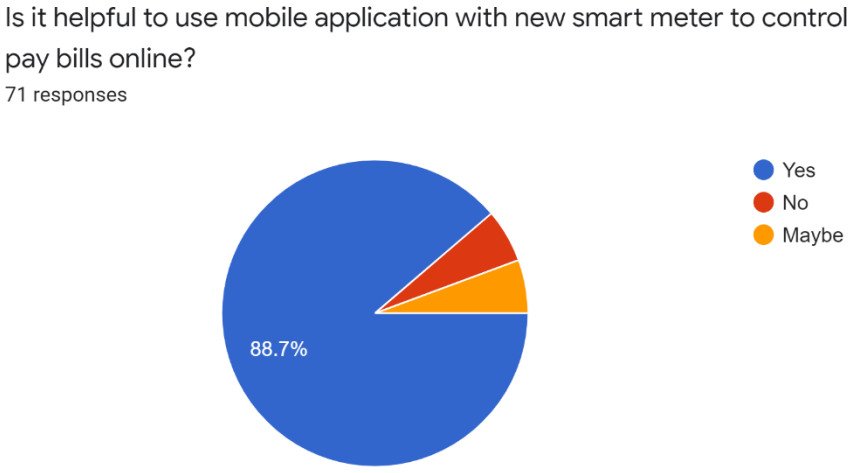


Figure 22 Public Survey 6

18.6 Product Quality

8. Initial quality plan	
Quality check	**Strategy**
Requirements	Requirements will be checked (within Stage 2) to ensure that they are correct, relevant (i.e., traceable to the business objectives), complete, achievable and demonstratable. Prototyping, user interviews and walkthrough will be employed.
Design validation	The design will be checked (within Stage 3) against requirements compliance, HCI guideline compliance, screen-design acceptance, DB normalisation and software design principles (e.g., cohesion, coupling)
Sub-system usability and validation	To be conducted at the end of each increment
System validation and user acceptance	To be conducted within Stage 7

Figure 23 Appendix: Quality Plan

18.7 Other Materials

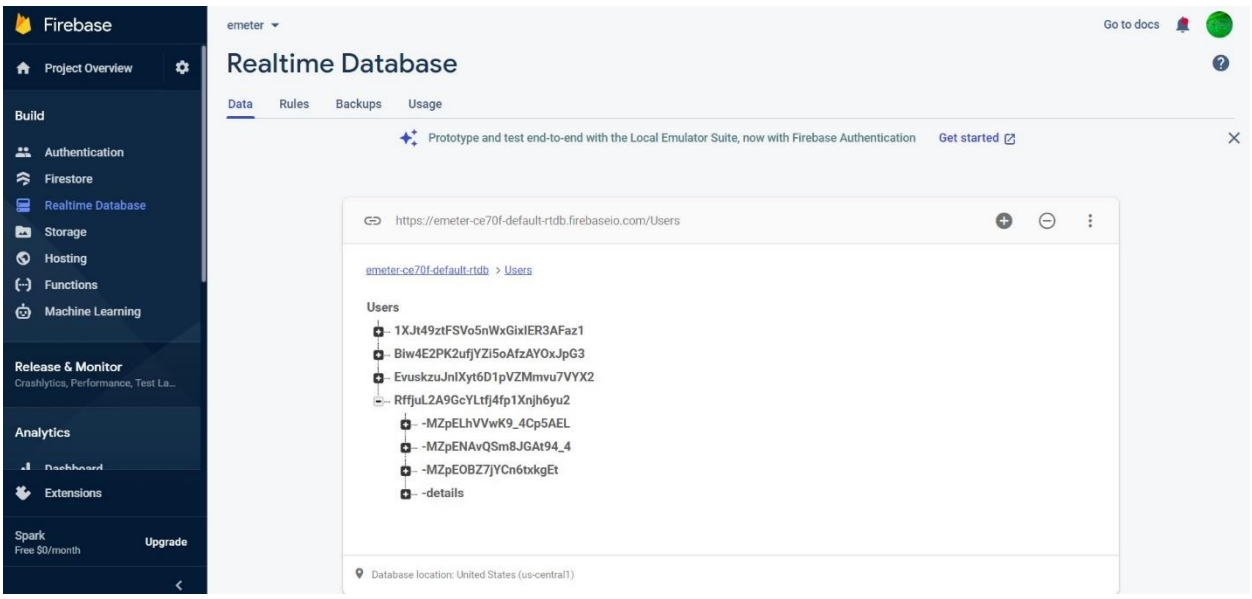


Figure 24 Appendix Firebase

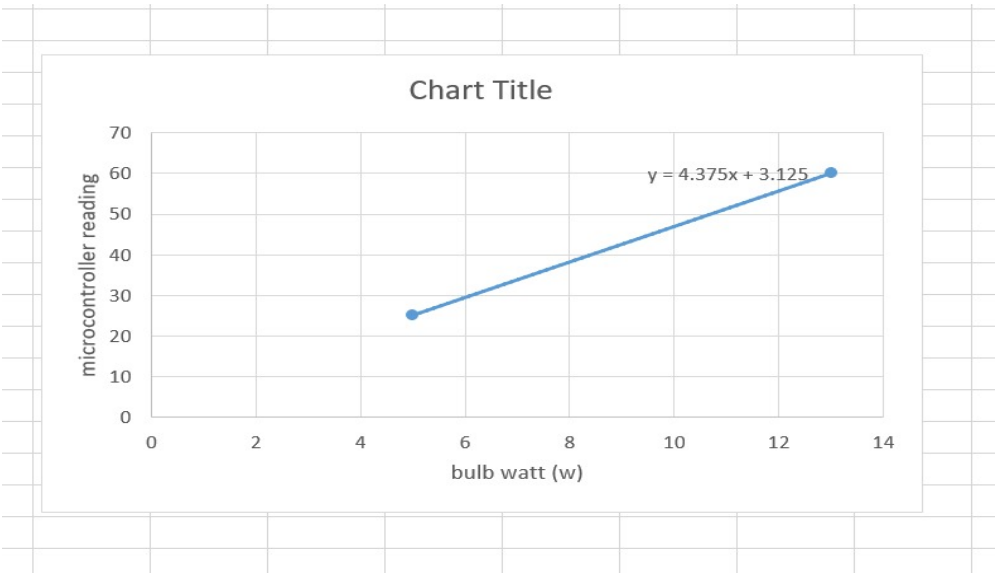


Figure 25 Appendix: Testing Output

18.8 Uses of Postman.

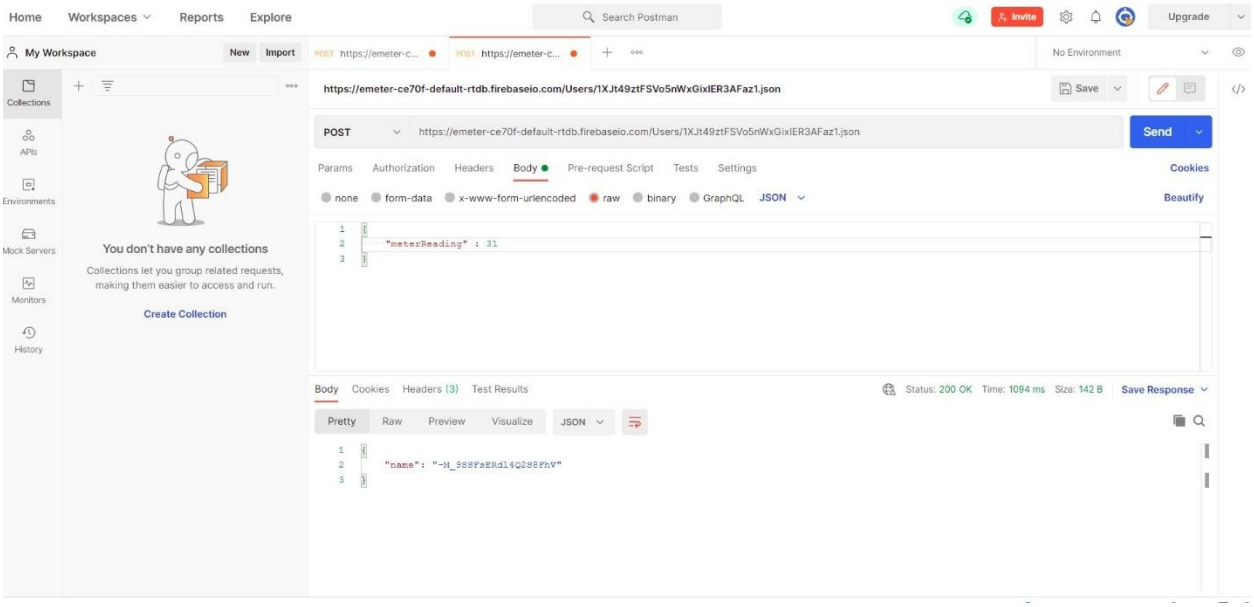


Figure 26 Appendix: Check with Postman

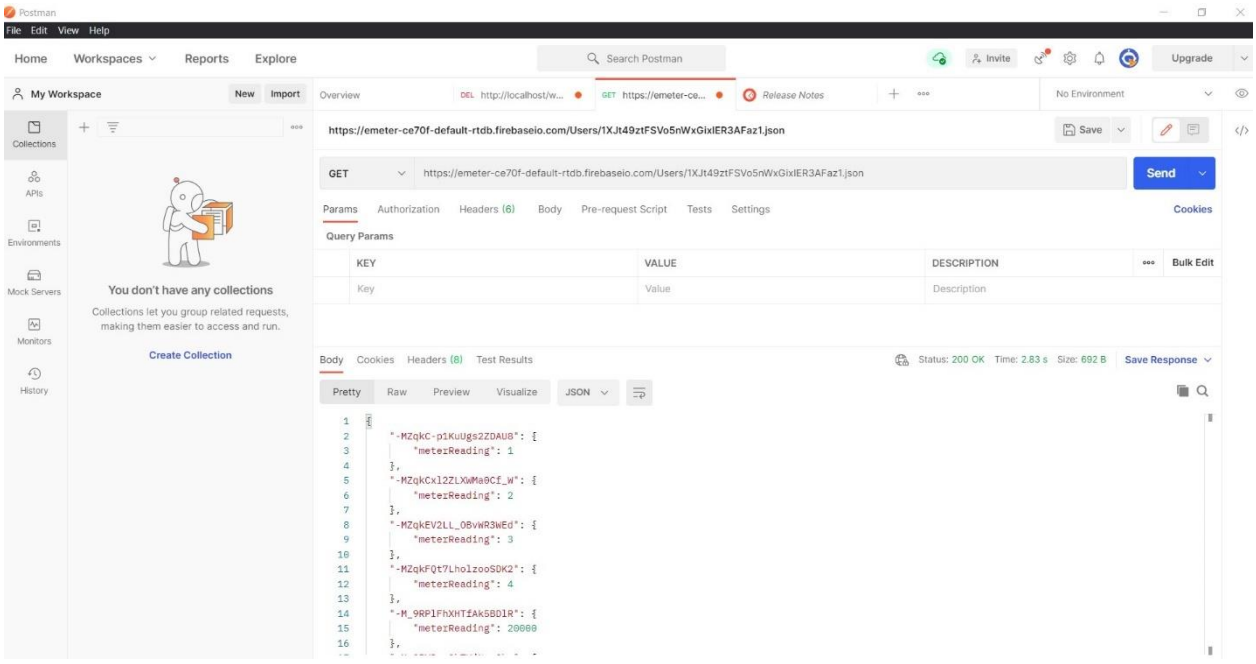


Figure 27 Appendix: Postman GET requests

18.9 Literature Review Figures

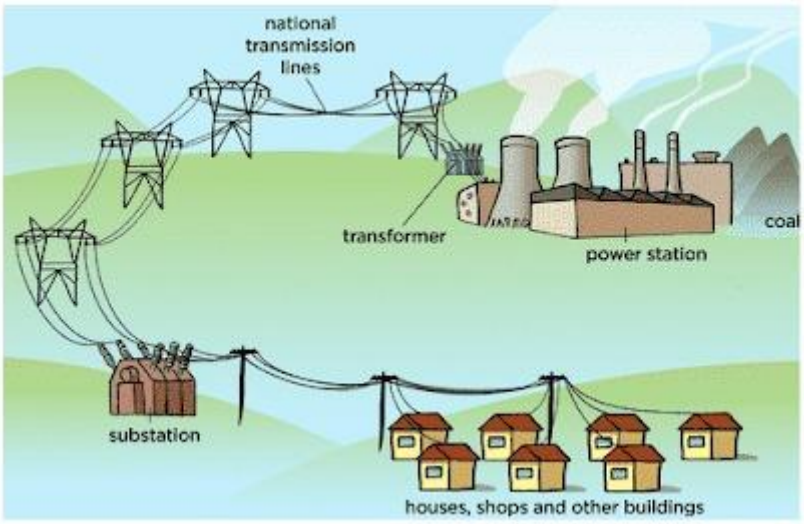


Figure 29 Appendix: National electric grid

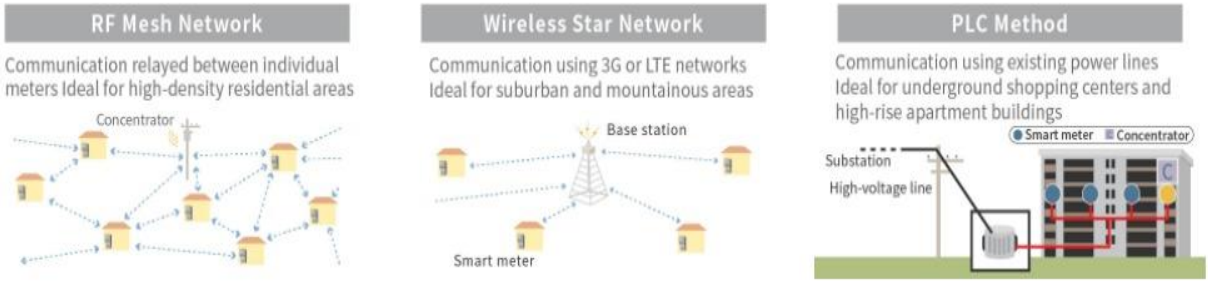


Figure 28 Appendix: Smart Metering systems in Japan.

18.10 Resources Used

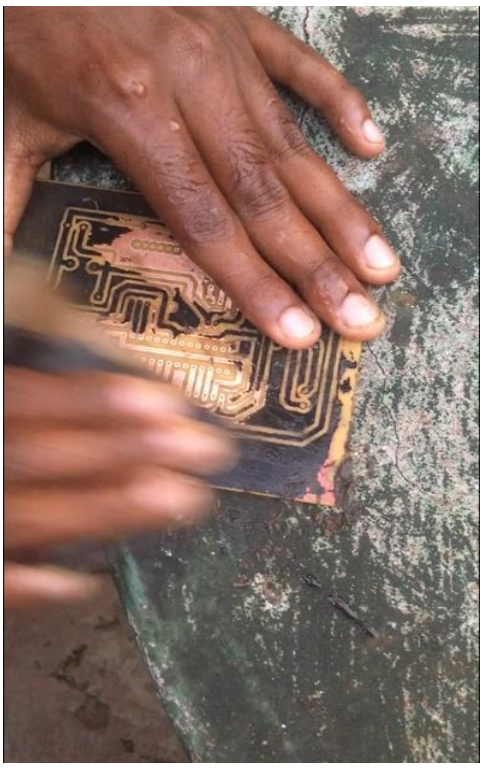


Figure 31 Appendix. PCB etching

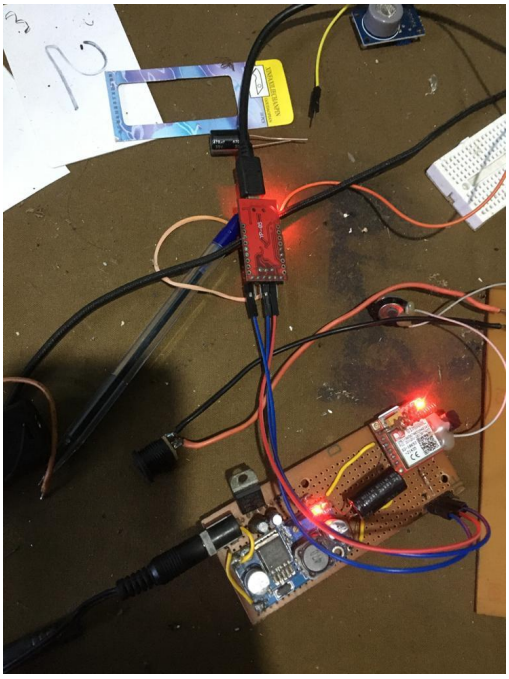


Figure 30 Appendix: GSM module Testing

Figure 32 Appendix: PCB Etching

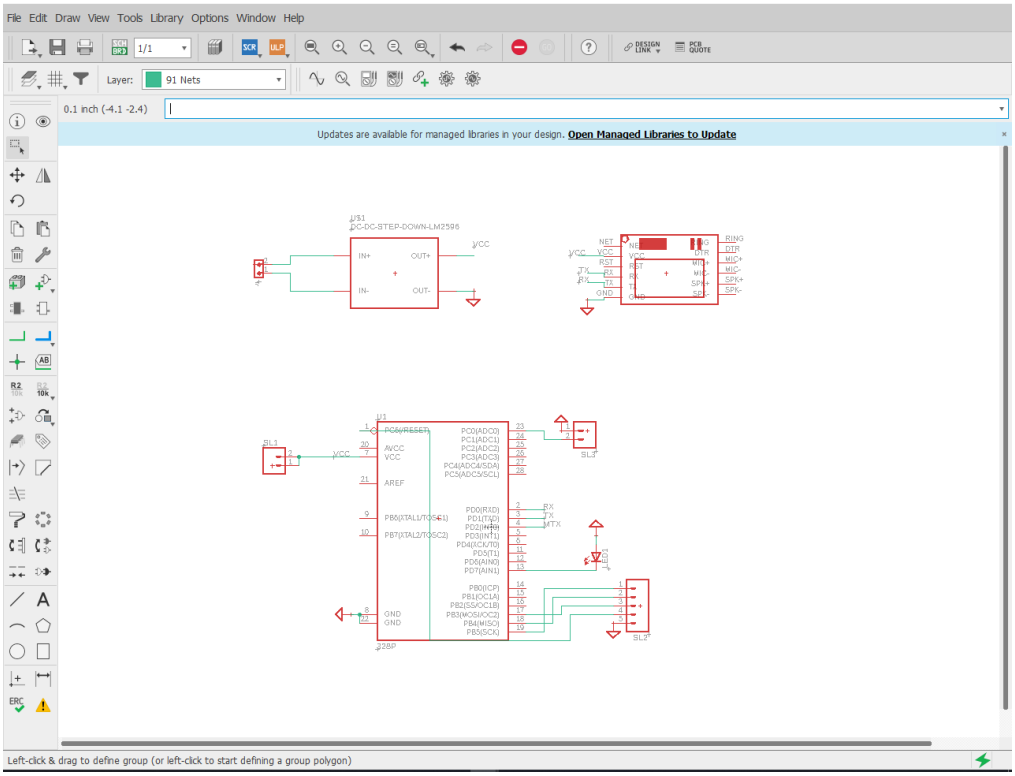


Figure 33 Appendix: Circuit Diagram

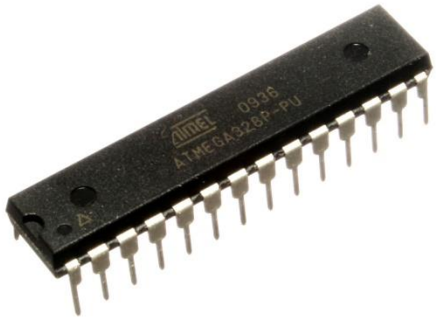


Figure 35 Appendix: Atmega 328p

Figure 34 Appendix: Sim800l GSM module

18.11 User Interface Design

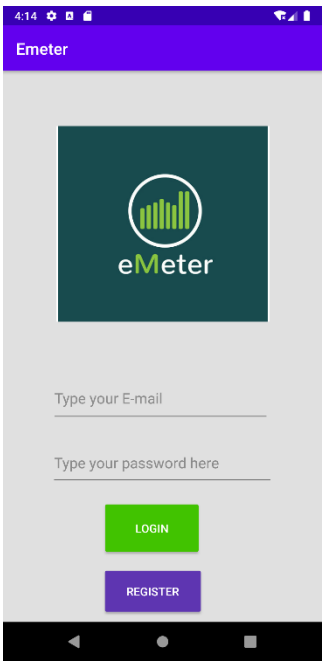


Figure 39 Appendix: UI 1

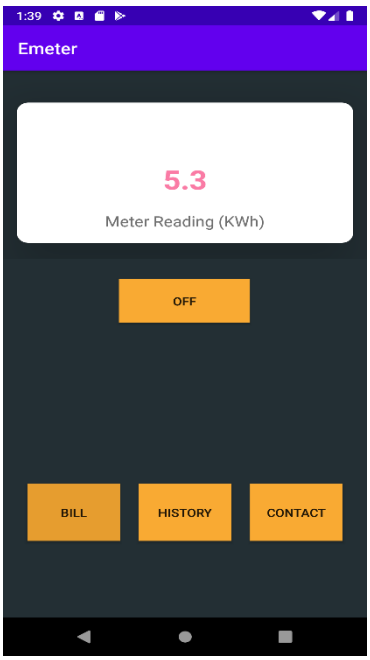


Figure 38 Appendix: UI 2

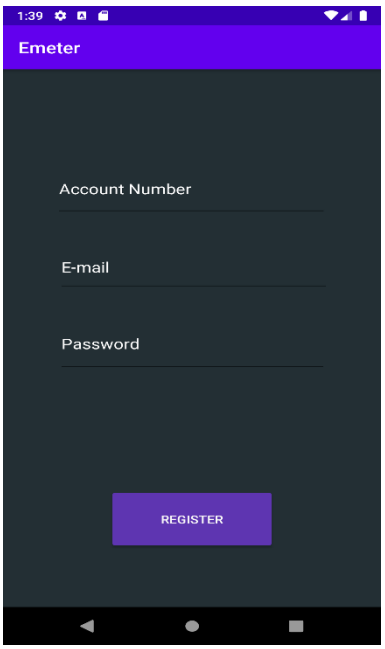


Figure 37 Appendix: UI 3

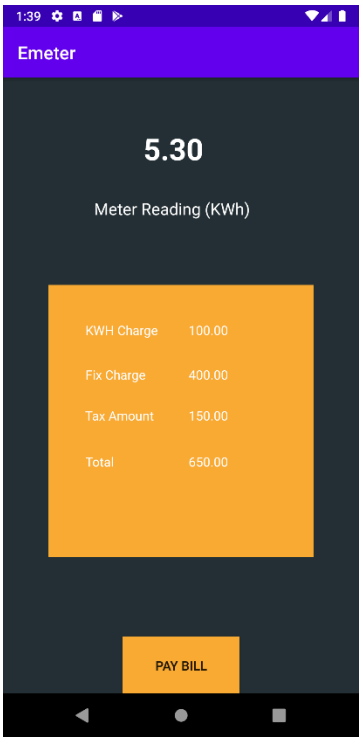


Figure 40 Appendix: UI 4

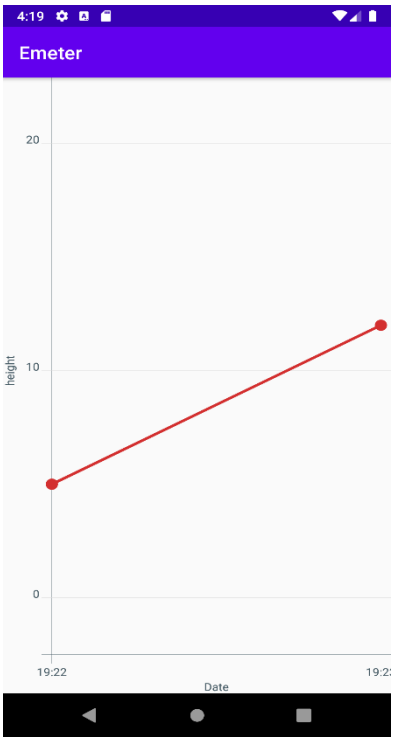


Figure 36 Appendix: UI 4

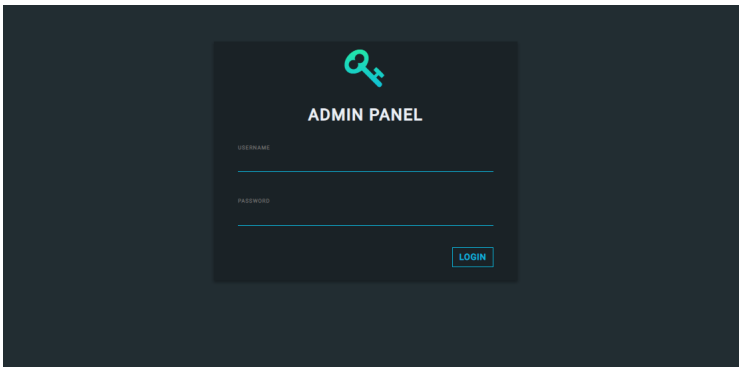


Figure 42 Appendix: UI 6

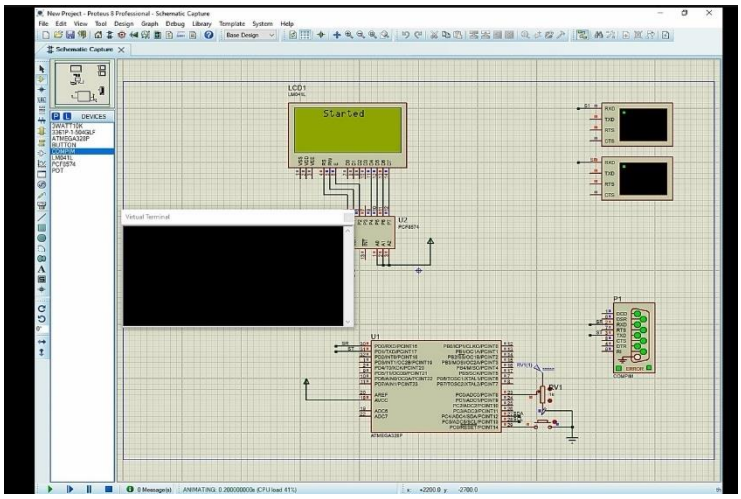


Figure 41 Appendix: Simulation testing

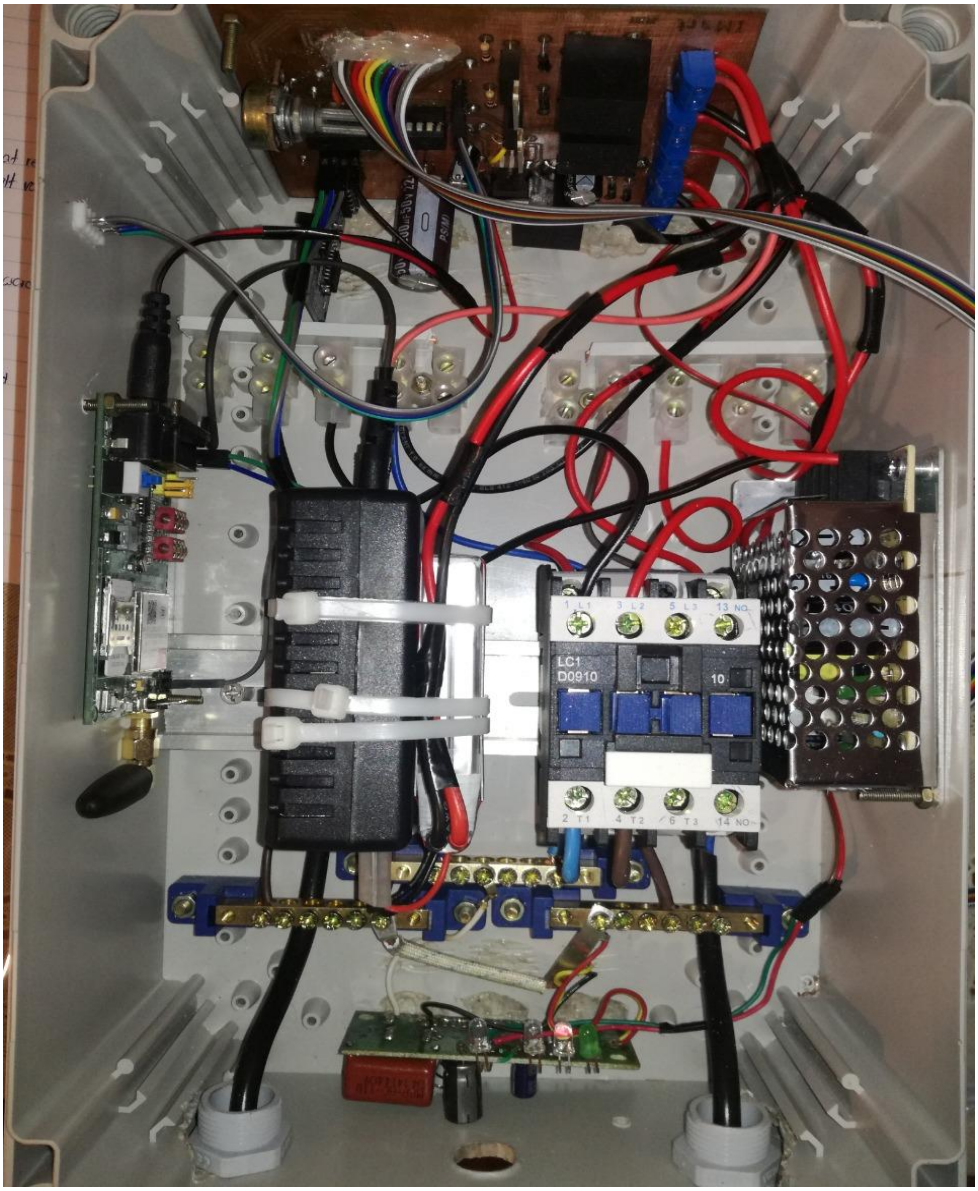


Figure 43 Appendix: Smart meter