INFORMATICS INSTITUTE OF TECHNOLOGY

Foundation Certificate in Higher Education

Module : DOC330 Designing Innovative Solutions

Module Leader : Jananie Mayooresan

Assessment type : Interim Project Report

Assignment Group : B-1

Project title : "Smart U" - Utility Monitoring system

Issue Date : 7th February 2022

Hand – in – Date : 2nd March 2022

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Abstract

One of the world's major issues is the management of utility resources. Energy consumptions have been conspicuously arising since the mid-2000s, but few advances have been made to solve the problems in Sri Lanka with a strong long-term strategy based on a high technological basis and acknowledging the numerous beneficial improvements occurring in this sector elsewhere around the world. Nowadays, our dependence on electricity is powerful because power consumption has augmented significantly within the last few years. Because of this, economical use of electricity is crucial, particularly in an organizational setting. Therefore, to manage the utility consumption, whether it's an individual resource or an entire organization, Today's smart systems are intelligent and versatile to manage a balanced approach to controls and offer operational efficiency. This Group B-1 report explains the development of "SMART U," a user-friendly and smart utility monitoring application, which will analyze the user's data and provide measurable metrics to obtain insight into their usage. Furthermore, the program can monitor the energy usage of an appliance via IoT integrations and installed sensors into end-user’s premises. The introduction to the project, the issue statement for the following development, and the important benefits that the user will obtain from the finished product are all concluded in this report.

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1. Introduction and Description of the Project

Nowadays, people are consuming electricity at an increasing rate. It is critically important for people to be able to save energy and reduce excessive consumption to reduce cost and resources. Especially in Sri Lanka where the primary source of electricity comes from non-renewables such as coal and oil and the current renewable sources are inconsistent and cannot generate enough electricity to meet the increasing demand. That's where "SMART U", an application using data analysis, user's will gain insight on their usage through measurable metrics. With the use of Internet of Things (IoT) methods to create a smart monitoring system, this wireless energy monitoring device uses internet communication to acquire characteristics from a digital energy meter. In addition, the system generates an online real-time power consumption report. As a result, the user can save electricity and become more mindful of power usage (R.Govindarajan, 2019). Therefore, they can reduce excess consumption and improve a properties' energy use efficiency whilst saving time and money.

1.1 Project Aim

This project aims to design an application that will gather data from the user through user input and installed sensors, perform analysis on the gathered data, and display a dashboard containing information about the user's electricity usage and other energy-saving insights.

1.2 Project Objective

The objective of this project is to implement reliable and accurate utility management solutions to help reduce excessive consumption and improve energy efficiency. Through the monitoring of user's electricity usage using sensors, provide analysis on data and give user's status updates on their energy consumption and ways they can save energy.

1.3 Project Scope and Limitation

This project is complete when it can accurately determine the number of units consumed monthly and can calculate the appropriate billing amount. As well as determine the number of units consumed by any connected appliances. However, due to its reliance on gathered data, the application may be inaccurate for the first few months of use.

1.4 Project Justification

This project would be able to contribute to the ongoing energy crisis in Sri Lanka by accurately determining energy usage. It can help reduce consumption rates and free up government manpower and time.

2. Problem Specification

Currently the present method for measuring utility usage is by sending an employee to every household to collect readings from utility meters, while the data is manually entered into a billing software and sent to consumers.

Ideally, there would be a system where you can monitor and control the readings from meters remotely. Thus, reducing labor costs whilst improving the reliability of the readings. With reliable data, users would be able to set up automatic bill payments through banking services to ensure that those bills are paid on time.

The utility industry is undergoing a fast transformation. The rising need for sophisticated technology, smart cities, and electric transportation is colliding with the increasing demands for renewable energy and sustainability.

2.1 Energy Consumption.

Every day around the world, about 34% of the electricity that is made is wasted when it arrives at the customer's meter, and from there it continues to get wasted by the customer (U.S Energy Information Administration, 2020). In Sri Lanka, people face this problem as well. Individuals and organizations do not to save energy as there is a shortage of energy supply. Sri Lanka's primary energy supply comes from Petrol, Biomass, Coal, Major hydro, and other new renewable energy. With a shortage of fuel and energy supply, Sri Lanka has become harsher. The below chart shows the percentage of each energy supply that was used in 2017.

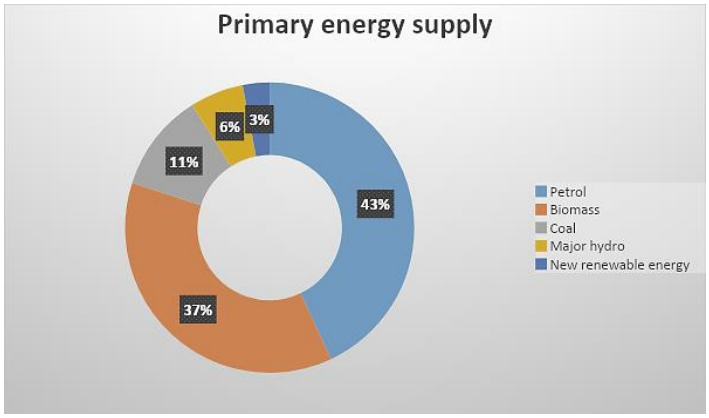

Figure 1 A Pie chart highlighting energy sources in Sri Lanka

(Sri Lanka Sustainable Energy Authority, 2017)

2.2 Use of both traditional analogue and digital meters.

The Ceylon Electricity Board (CEB) now uses both traditional analogue and digital meters to read the total power consumption, even though the readings are not ideal for longer operational reasons because it consumes a lot of human and material resources. It adds to the difficulties of manually calculating readings and charging. Compared to digital meters, analog meters are not that accurate and fast. As a result, maintaining power to meet expanding demands is a difficult task. If the customer isn't satisfied or unavailable, the billing process will be delayed, and a human operator will need to visit each customer's home to disconnect the power supply if the payment has not been paid. As a result, the billing system's issues might become incorrect and inefficient.

2.3 Cost of living.

In recent years, with the advancement of technology, the increase of population and change of people's lifestyle has impacted the lives of every individual rapidly. Even though the world is advancing with so many technologies, nowadays people don't have enough time to manage their utilities. Furthermore, the prices of basic utilities like water, electricity and gas have skyrocketed immensely. Therefore, citizens' cost of living has increased over the years. With these essential utilities being too expensive it makes citizens' day to day lives harder.

2.4 Organization's excessive usages of utilities

Same as the average citizen, organizations also depend on utilities heavily, but they tend to waste utilities unnecessarily and do not pay attention to utility bills as well. Many organizations can afford the bills of their utilities but most of them waste a lot of energy before they even consume it. If they manage it properly, they could save a significant number of resources, energy and save their finances.

3. Solution Outline

To the problem stated above, the solution proposed is “SMART U”. This application aims to tackle this problem by placing digital sensors in user’s homes which measure the number of units consumed.

3.1 Sensors

The sensor passes the information containing the number of units with time and date to a server that receives this data and calculates the total bill amount before sending that information to the user’s mobile phone or other requested mediums such as e-mail. Allowing users to view their bill amounts and the number of units consumed at any time.

3.2 Smart Switches

If the user has connected any IoT devices, installed sensors will automatically monitor the number of units used as well as detect when the appliance is turned ON and OFF and provide the user with critical information such as the number of units/per hour and display how energy-efficient the appliance. Furthermore, connected appliances give user’s access to force control which is the ability to turn the appliances ON or OFF through their smartphones.

3.3 Cloud Computing

Cloud computing will be used for this application as its scalability and its capacity to handle large volumes of data is essential for smart monitoring. Furthermore, the short delay time in data transfer is crucial to ensure the user gets real-time reports (R. Govindarajan, 2020)

3.4 Artificial Intelligence

A predictive analytic model or algorithms will be used on user’s data to generate trend analysis and predictive reports. As well as study patterns in appliance usage to recommend ways to save energy

Using the above-mentioned technologies in the product, can provide a vast number of features to the end-users. Below is a GAP analysis table highlighting and comparing features with other similar applications.

Features	Local Applications			Global Applications			SMART U
	CEB Care	ePro	Voltas	JadeTrack	Smappee	Neurio	
Real-Time Monitoring							
Cloud - Syncing							
Integration of IoT devices							
Intelligent saving guidance							
Calculating bill Payments							
Force - control							
combinations of service providers							
Personalized Insights on Usage							
Community forum							
Compatibilities of virtual assistants.							
Automated payment with biometrics.							
Energy on demand							
Multi factor authentication, Multi Login and end-end encryption							

YES	NO	INNOVATIVE	ONLY ONE

Table 1: GAP Analysis Table

4. Key Benefits

Smart home - Utility technology, also often mentioned as home automation or demotics, provides User security, comfort, convenience, and energy efficiency by allowing them to manage appliances, often by a wise home app on their smartphone or other network devices. A component of the internet of things (IoT), smart home systems and devices often operate together, sharing consumer usage data among themselves and automating actions that support the user's preferences.

4.1 Sustainability

SMART U can promote sustainability through features such as:

Real-Time monitoring- which helps users to analyze and display streaming data that will aid in reducing utility waste, recovering revenue, and analyzing your consumption data.

Intelligent saving guidance- Using Artificial Intelligence, it will analyze the utility usage patterns of the user's and provides energy-saving tips and recommendations.

Sharing stats with service providers- By providing consumption rate data of the consumers to utility providers. Utility providers would be in a better position to make informed decisions to increase the supply of energy.

Insights of utility usage- Artificial intelligence will analyze the user's data gathering insights on the user's usage whilst also providing trend analysis and predictive charts on utility usage for future months based on previous data.

4.2 Accessibility and Accuracy

Multiuser Login- This allows two or more trusted user's access to control and analyze their utility; control can only be given by the primary device.

Cloud–Syncing- By storing data on the cloud users can access their utility information anywhere at any time from any device.

Integration of IoT devices and appliances- IoT home automation is the ability to control domestic appliances by electronically controlled internet-connected systems, Furthermore, users can manage these appliances remotely through the application allowing them to turn them ON and OFF as well provide notifications when the appliances are turned on as well as gather data about connected appliances energy consumption.

Calculating bill payment amounts- Through the gathered data the application automatically calculates and charts the user's utility usage allowing the user to make comparisons to the previous month's bill amounts. In addition, artificial intelligence would analyze and display future monthly or annual bill amounts based on previous data.

Multiple platforms Support – SMART U will be supported on IOS and Android.

Community Forum – Users can create a community forum inside the application where users can receive important utility-based news such as power cut or water cut from the forum.

Online customer support - This allows users to contact the developers for any problem their facing in the app or instructions-based help to use the application.

4.3 Security & Privacy

Multi-Factor authentication- Users must provide two or more pieces of evidence to verify their identity to gain access to an app, OTP, or digital resource. Multi-factor authentication is used to protect against hackers by ensuring that user's access and databases are safe.

End to end encryption - End-to-end encryption will prevent third parties from accessing the collected user's data while it's transferred from one end system or device to another. In end-to-end encryption, the data is encrypted on the sender's system or device which protects the user's data

Biometrics and Face ID unlocking - This allows user's biometrics or face id to access and use the application and is also used for confirmation of payments.

References List

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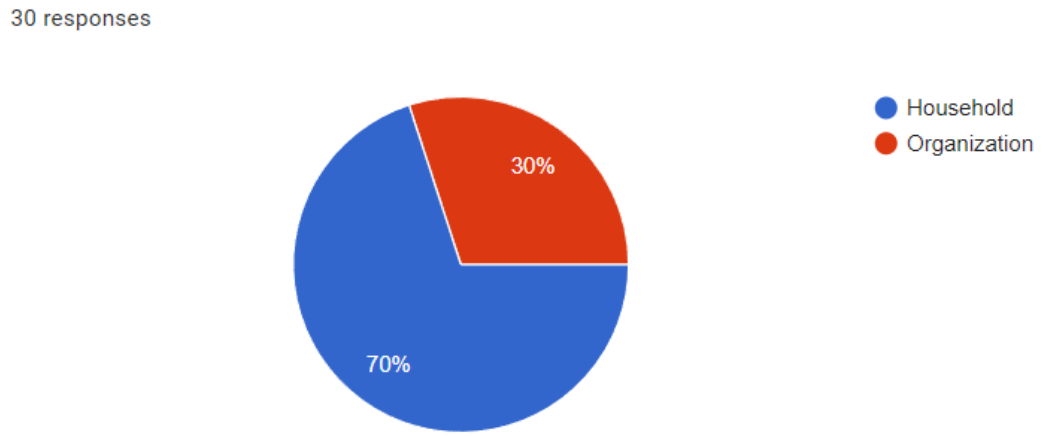
Available at: https://www.eia.gov/totalenergy/data/flow-graphs/electricity.php
[Accessed 24 February 2022].

6.Appendices

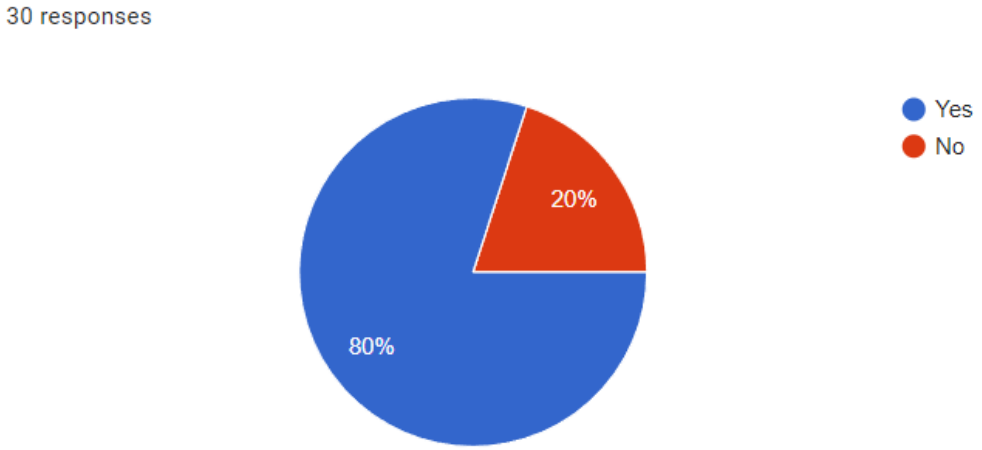
6.1 Idea Validation Survey Summary

The Group B-1 have conducted a survey regarding the "SMART U" Application via google form. Respondents were asked 16 different questions in the survey. Below are responses to some of the questions.

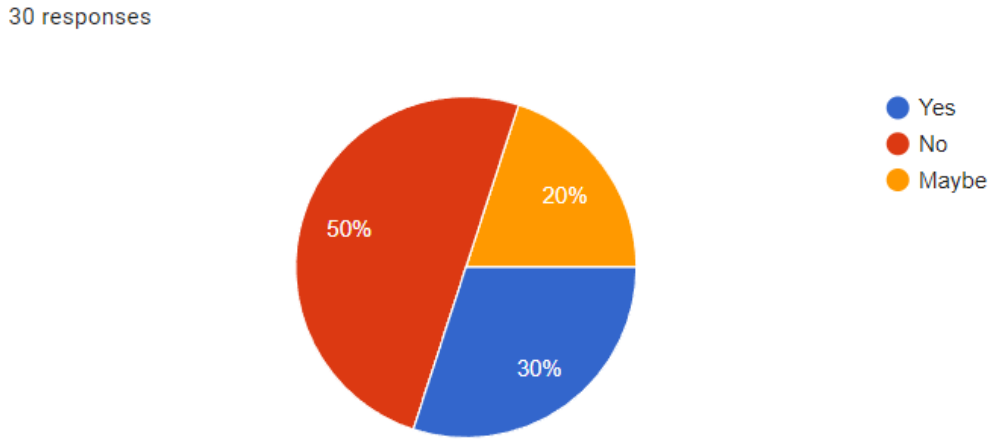
1. Do you used to manage the utility bills of a household or are you representing an organization?



2. Do you think your electricity bill is too expensive?



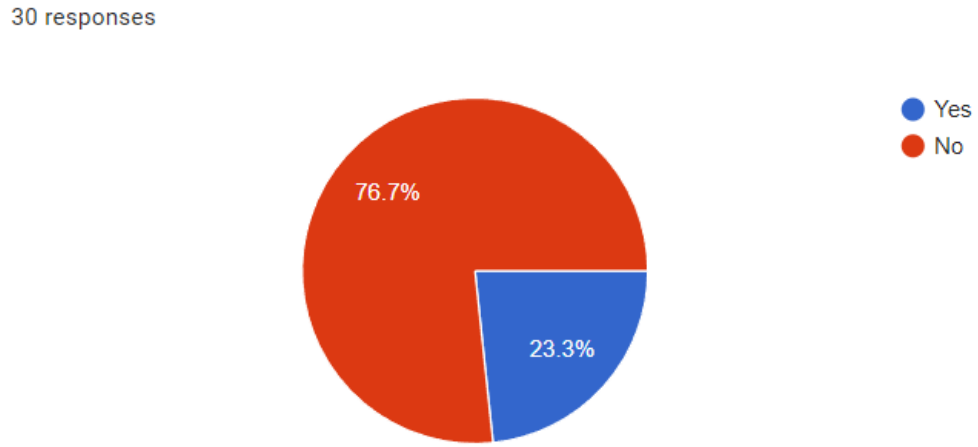
3. Do you have enough time manage your utility bills?



4. What's the reason for the above (3) answer?

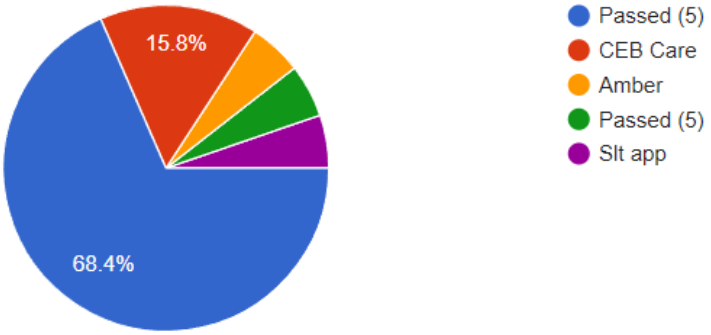
Majority of the respondents have answered as they don't get enough time look after their utilities.

5. Have you used any applications to manage and monitor your utilities?



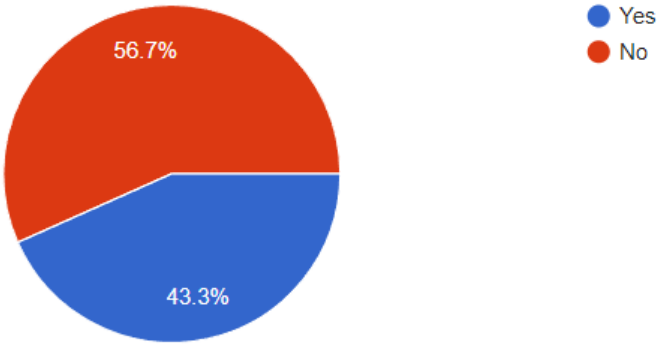
6. If you answered "Yes" to Question 5: Write down the name of the application

19 responses



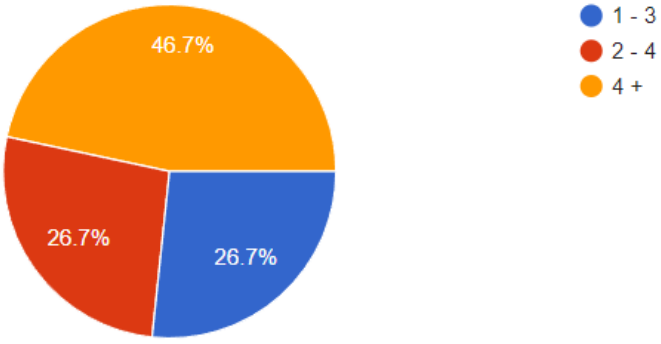
7. Do you use the Application now?

30 responses



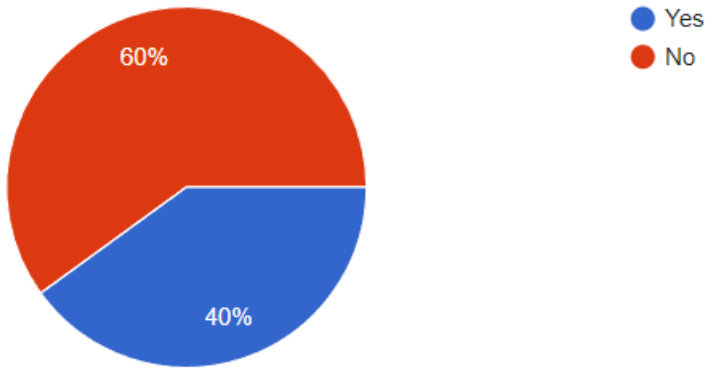
8. How many people in your household?

30 responses



9. Have your organization use such applications to manage their utilities?

30 responses



10. Which of these features would you most enjoy in a utility management application.

29 responses

6.2 Workload Matrix

Topics		Members' Contributed	Contribution
Title Page		Aamil Aliyar	Making of the cover Page
Abstract		Aamil Aliyar	Abstract for the Report
Table of Contents		Akshith Rajendran, Udhayahkkumaar Vathshaalan	Creating the table of contents
Body of the Report	Introduction and Description of the Project	Akshith Rajendran, Mohamed Sabath	Contents for Introduction of the report – Akshith Gave ideas - Sabath
	Problem Specification	Manuga Perera Akshith Rajendran	Manuga – Contents, Charts Akshith – Content, editing
	Solution Outline	Aamil Aliyar Akshith Rajendran	Akshith – Contents Aamil – Gap Analysis
	Key Benefits	Udhayahkkumaar Vathshaalan Aamil Aliyar	Vathshaalan and Aamil – Content and Explanations
References		Manuga Perera, Akshith Rajendran	Citation – each member to the relevant contents they provided. References List – Akshith, Manuga
Appendices		Aamil Aliyar Mohamed Sabath	Annexed the Survey responses summary, Table filling, Editing and Proof Reading

6.3 Meeting Agenda Table

Meeting Agenda	Note
Meeting 1: Topics Discussed • Brainstorming on the project ideas • Delegated task to members	Start and End Time: 9:30PM-10:15PM Location: WhatsApp Date: 10/02/2022
Meeting 2: Topics Discussed • Review of information gathered by members • Creation of cover page and Solution outline	Start and End Time: 7:00PM-9.25PM Location: Zoom Date: 12/02/2022
Meeting 3: Topics Discussed • Correction in the project idea • Corrected content errors related to Key Benefits	Start and End Time: 4.00PM - 6.00PM Location: Zoom Date: 16/02/2022
Meeting 4: Topics Discussed • Review and corrections of Problem Statement	Start and End Time: 6.30PM - 7.30PM Location: Zoom Date: 17/02/2022
Meeting 5: Topics Discussed • Review and correction of report • Delegated tasks	Start and End Time: 8.00PM - 9.00PM Location: Zoom Date: 19/02/2022
Meeting 6: Topics Discussed • Designed Survey Summary • Proofreading and editing of report	Start and End Time: 7.30PM - 8.00PM Location: Zoom Date: 21/02/2022
Meeting 7: Topics Discussed • Final review and correction of report • Allocating final tasks • Proofreading and editing of report	Start and End Time: 4.00PM - 5.00PM Location: WhatsApp Date: 25/02/2022
Meeting 8: Topics Discussed • Finalizing the IPR	Start and End Time: 6.00PM - 6.30PM Location: Google Meet Date: 28/02/2022