

Design and Development of Residential Estimated Bill Electricity Calculator Using Android Studio

**Nurul Ismahani Mohd Jaswadi¹, Nor Akmal Mohd Jamail^{1*},
Qamarul Ezani Kamarudin²**

¹Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400, Johor
MALAYSIA

²Faculty of Mechanical and Manufacturing Engineering,
Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400, MALAYSIA

*Corresponding Author Designation

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Abstract: The Residential Estimated Bill Calculator Application is a simple and straightforward mobile application created using Android Studio. By offering a trustworthy and open platform for bill estimation, it seeks to allay residents' rising worries about their electricity bills. The goal of this project is to design a residential bill estimated calculator and to analyze the performance of the calculation application for residency. The other purpose of this application development is to compare the result of the application with the Tenaga Nasional Berhad (TNB) bill system. The system was designed using Android Studio and Flutter. The coding was run in the Android Studio using the Dart Language. Flutter was used to build cross-platform mobile applications. The performance of the application was analyzed by using the system. Once the system shows the desired result interface, it means the system functionally works smoothly. The TNB's bill calculator system was used as a reference to compare the results of the residential estimated bill calculator whether it was accurate and trustworthy. About 90% of the system that was developed was accurate with the TNB's system. The residential estimated bill calculator was successfully designed, and the performance of the calculation application was analyzed with the use of Flutter. Based on the comparison result, the residential estimated bill calculator is more convenient because the system requires the user's house load but the result is less than 10% more accurate. In conclusion, the developed system was a user-friendly type and it also went through the analysis step to make sure that the calculation results were accurate with the TNB's system.

Keywords: Estimated bill, Android Studio, TNB's system

1. Introduction

The electrical load can be defined as a device that converts electrical energy from current consumption into other forms, such as heat, light, and work. The domestic load is one of the electrical loads under the power system load [1]. Residential or households are the consumers of this domestic load in terms of electrical consumption. Electricity is crucial in our daily lives, as it powers our routines at home, school, malls, and workplaces. From waking up to going to sleep, electricity plays a vital role such as powering alarms, lighting, cooking, heating, and refrigeration. Without electricity, productivity and quality of life can be negatively affected. Additionally, modern communication systems heavily rely on electricity. However, people may not realize that power usage in homes is increasing due to the growing number of electrical devices, which contributes to higher electricity bills. In Malaysia, residential energy use has significantly increased over the past year, which has led to a high demand for electricity to keep up with rising social and economic activity [2]. The residential sector has contributed 20.7% of Malaysia's overall energy consumption in recent years [3].

Malaysia faces a significant challenge with the high cost of living, particularly in its capital city Kuala Lumpur [4]. The rising cost of basic needs like food, clothing, and rent, as well as other amenities such as education and electricity bills, has affected the nation for a long time. From the viewpoint of the customer, it is impossible to determine their current electricity usage or manually calculate it using the provided formula [5]. The Energy Commission of Malaysia reported that the average household's electricity use in Peninsular Malaysia in 2019 was about 455 kilowatt-hours (kWh) per month [6]. To address the issue of unpredictable electricity expenses, developers have proposed a user-friendly application that allows citizens to estimate their monthly bills based on load types, hours of usage, and estimated power. This application aims to help the residents budget their expenses and alleviate financial stress.

This research paper focused on three main objectives. First, it aimed to design a residential bill estimated calculation application specifically for residential use. This application was intended to assist users in estimating their monthly electricity bills more accurately. Second, the performance of the calculation application was analyzed to evaluate its effectiveness and reliability. This analysis provided insights into the application's accuracy and usefulness in helping residents budget their expenses. Finally, the results obtained from the application were compared with the actual electricity bill issued by Tenaga Nasional Berhad (TNB), the national utility company. This comparison assessed the application's ability to provide estimates that aligned with the official bills, thereby validating its accuracy and practicality.

2. Materials and Methods

In this section is the explanation of the methodology and materials used to conduct this project.

2.1 Materials

The specifications and properties of materials, equipment, and other resources used in the current study are described in this section.

(i) Android Studio

An application for Industrial Power Load Calculation will be built using the Android Studio software. Android Studio is the official integrated development environment (IDE) for Android app development built and distributed by Google [7]. An IDE contains tools that make it easy for software developers to design, build, run, and test software, in this case, apps for the Android platform [7]. The program was initially introduced at Google I/O in May 2013, and the first stable build was made available in December 2014 [8]. For desktop operating systems, Android Studio is accessible on Mac, Windows, and Linux. As the main IDE for developing Android applications, it took the role of Eclipse Android Development Tools (ADT) [9]. Android Studio uses a Gradle-based build system, emulator,

code templates, and GitHub integration to support application development for the Android OS [8].

(ii) Flutter and Dart Language

Flutter is well supported by Android Studio, the official Integrated Development Environment (IDE) for Android app development. Many Flutter developers who work on Android apps favor it because it provides tools, debugging options, and plugins especially made for Flutter development. Google’s portable UI framework for building advanced, native, and responsive apps for iOS and Android is called Flutter. Google is also developing Flutter for embedded devices, the Web (Hummingbird), and desktop embedding [10]. The language you’ll use to build your Flutter applications and the application interface is called Dart [10].

Dart is a programming language specifically designed for developing high-performance applications across multiple platforms. Its primary objective is to provide developers with a productive and efficient language for creating multi-platform applications, complemented by a flexible runtime platform for app frameworks [10]. Dart serves as the fundamental building block of the Flutter framework. In addition to powering Flutter apps, Dart offers a comprehensive set of tools and functionalities to support core developer tasks, including code formatting, code analysis, and code testing.

2.2 Methods

Procedures of this project have been described using flowcharts in which case the chart will be considered as Figure 1. It contains three stages to finish this project. The first stage involved the building and designing of the application. This included gathering requirements, creating a conceptual design, and implementing the application through coding and programming. The system was checked again if it did not meet the system’s requirements. Then, it was followed up by the analytical performance of the system to see its effectiveness, reliability, and accuracy. Lastly, the comparison result from the application built with the TNB’s system because TNB was the main power supplier in Malaysia.

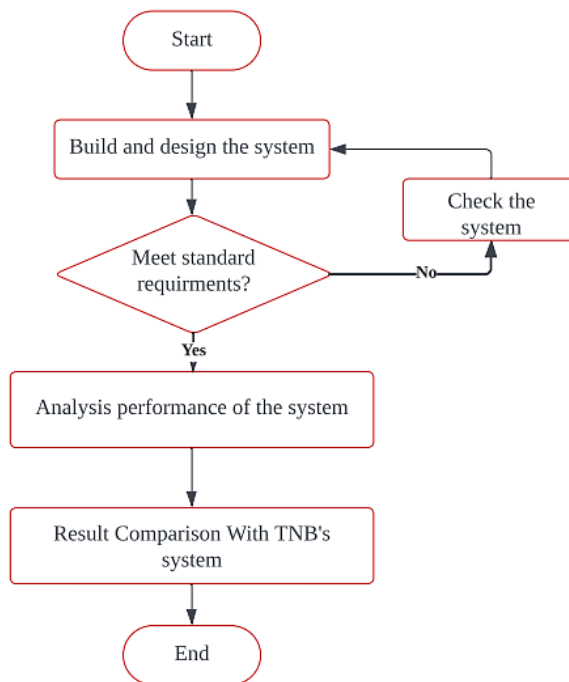


Figure 1: Flowchart of project methodology

(iii) Design And Development Phase

The project began with the design phase where the developer designed the look, button arrangement, and other elements. It was more on planning, conceptualizing, and specifying the requirements of the application. Android Studio software that plugged with Flutter was used to build the residential estimated bill calculator. The build phase covered the actual coding, implementation, testing, and deployment of the software based on the design specifications. Figure 2 and Figure 3 show the coding for the input and output of the application.

```
void showAddLoadDialog() {
  showDialog(
    context: context,
    builder: (context) {
      return AlertDialog(
        title: Text('Add Load'),
        content: SingleChildScrollView(
          child: Column(
            children: [
              TextField(
                controller: nameController,
                decoration: InputDecoration(
                  labelText: 'Load',
                ), // InputDecoration
            ), // TextField
              TextField(
                controller: quantityController,
                keyboardType: TextInputType.number,
                decoration: InputDecoration(
                  labelText: 'Quantity',
                ), // InputDecoration
            ), // TextField
            ],
          ),
        ),
      );
    }
  );
}
```

Figure 2: Input coding for the system

```
void removeLoad(int index) {
  setState(() {
    totalPower -=
      loads[index].quantity * loads[index].estimatedPower + loads[index].usage;
    totalPowerByDay -=
      loads[index].quantity * loads[index].estimatedPower + loads[index].usage / 1000;
    totalPowerByMonth -=
      loads[index].quantity * loads[index].estimatedPower + loads[index].usage * 30 / 1000;
    loads.removeAt(index);
    estimatedBill = calculateEstimatedBill();
  });
}
```

Figure 3: Output coding for the system

(iv) Performance Analysis of The System

A representative sample of test data was compiled, covering a range of usage scenarios. The statistics included information on various appliance types, usage patterns, and power usage. Figure 4 shows the user used Flutter the place where of residential estimated bill calculator was built in to evaluate the system.

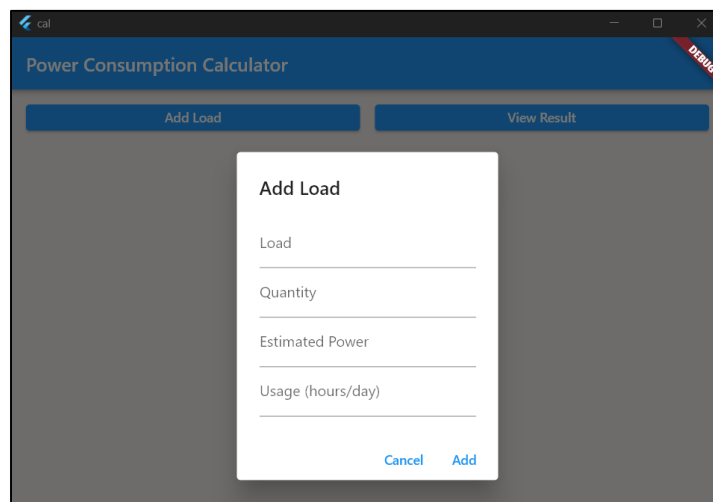


Figure 4: Residential estimated bill calculator interface

(v) Result in Comparison with TNB’s System

The development of the system was completed in this phase. The user was able to start performing calculations on the electricity bill by entering all the required data and was able to see and know the accuracy of the electricity bill of their house. The result of the built system was compared with the TNB system’s result. The TNB’s system was used by the user as shown in Figure 5.

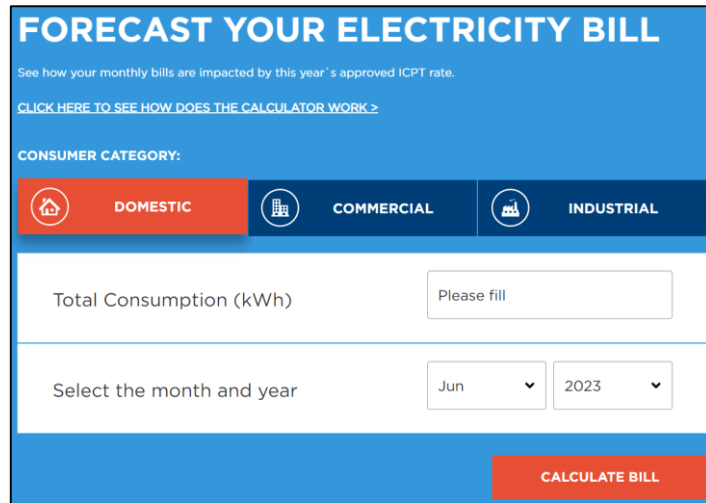


Figure 5: TNB's system [11]

2.3 Equations

The amount of energy used over a specific time is referred to as total power consumption [12]. The total energy consumed within 24 hours was referred to as the total power consumption for the day while the sum of all the electricity used within a month was called as total power consumption for a month. Total power consumption in kWh can be calculated using the equation 1 and 2 as follows:

$$T_{power\ per\ day} = \frac{Estimated\ power(W) \times Quantity \times Usage\ per\ house}{1000} \quad Eq. 1$$

$$T_{power\ per\ month} = \frac{Estimated\ power(W) \times Quantity \times Usage\ per\ house \times 30}{1000} \quad Eq. 2$$

3. Results and Discussion

The design and development results of this system were discussed in this section. The section also presented the analysis performance result of the system and followed up with the comparison results with the TNB system.

3.1 Application Design and Development

The residential estimated electricity bill calculator's input interface design is shown in Figure 6. In the interface, the user was able to enter the type of load, quantity, estimated power, and usage hour per day. An "Add load" button to allow the user to enter more than one type of load. Figure 7 shows the output interface of the residential estimated bill. The figure, shows the total power consumption per day (kWh), total power consumption per month (kWh), and the estimated bill (RM). Based on the result of both interfaces, it met the required conditions that had been set by the developer.

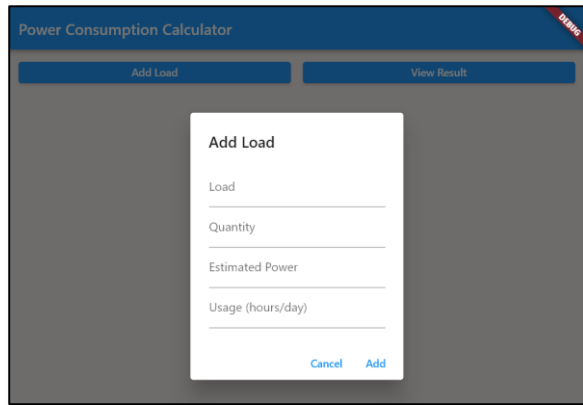


Figure 6: Application input interface



Figure 7: Application output interface

The estimated bill was calculated using the TNB’s tariff block. In Malaysia, Tenaga Nasional Berhad (TNB) was the main power supplier. For the system, it was vital to follow the TNB’s tariff formula in the design part to ensure the system shows the desired result. Table 1 shows the calculation of total power consumption and Table 2 shows the manual calculation of the estimated bill. The result, shows the result of total power consumption was 976.08 kWh per month and the estimated bill was RM 439.04. Both results from manual calculations show accuracy and aligned with the system result as shown in Figure 8.

Table 1: The types of loads and total power consumption

Type of Load	Quantity	Estimated Power	Usage Per Hour	Daily Load Consumption(kWh)
Fluorescent Lamp	8	24	8	1536
LED downlight	10	18	8	1440
Ceiling Fan (60’')	10	46	14	6440
Refrigerator	1	350	24	8400
Air conditioner With Inverter	2	880	7	12320
Television	1	150	6	900
+Washing Machine	1	500	3	1500
Total Power Consumption by Day (kWh)				32.54
Total Power Consumption by Month (kWh)				976.08

Table 2: The manual calculation using TNB’s tariff.

Rate per kWh	Bill Calculation	Estimated Bill (RM)
First 200 kWh (1-200 kWh) per month	967.08 – 200 = 776.08	$\frac{200 \times 21.8}{100}$ = 43.60
Next 100 kWh (201-300 kWh) per month	776.08 – 100 = 676.08	$\frac{100 \times 33.4}{100}$ = 33.40

Next 300 kWh (301-600 kWh) per month	$676.08 - 300$ $= 376.08$	$\frac{300 \times 54.6}{100}$	154.80
Next 300 kWh (601-900 kWh) per month	$376.08 - 300$ $= 76.08$	$\frac{300 \times 54.6}{100}$	163.80
Next 901 kWh Onwards per month	$=76.08$	$\frac{76.08 \times 57.1}{100}$	43.44
Total Estimated Bill per Month			439.04

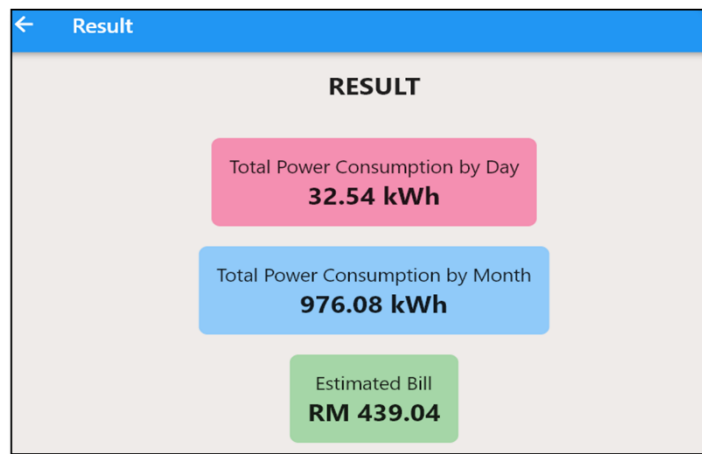


Figure 8: The estimated result from the application

3.2 Analysis of The Application Performance

Modern web applications were created with the assistance of powerful tools and technologies such as Android Studio and Flutter, which offered advanced features for developing user-friendly and highly interactive apps that provided high-quality user experiences. To ensure the system can run smoothly, it was very important for a developer to analyze the system first. The analysis of the application’s performance was conducted by observing its functional behavior. Since the main purpose of its development was to allow the user to enter their data, first the user entered the required data by clicking on the “Add Load” button as shown in Figure 9. After finishing entering the required data, the user can push the “Add” button, and then all the data is shown like Figure 10. In that figure, the icon trash bin allows user to delete the data they entered. By clicking the “View Result” module, the result of the total power consumption and the estimated bill was displayed as shown in Figure 11. The interface of output that displayed the result showed that the system can perform as smoothly as the purpose of it should.

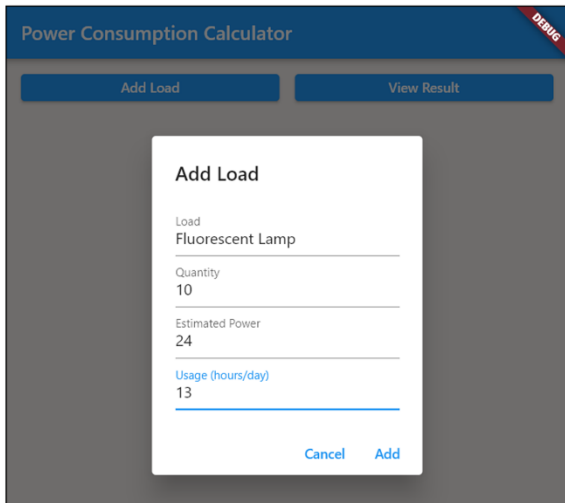


Figure 9: User interface for entered data

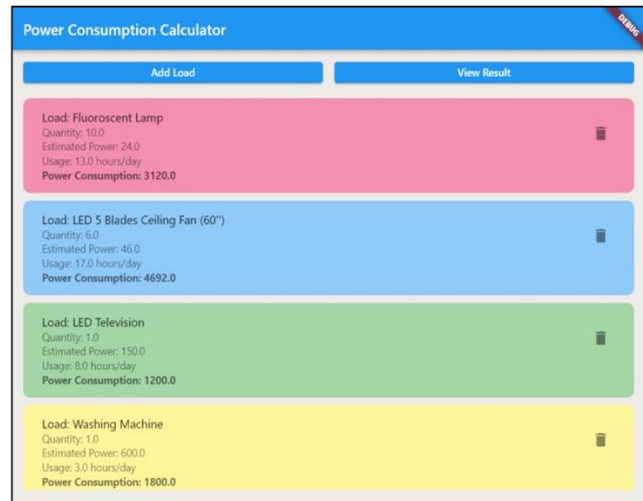


Figure 10: Main interface after entering data



Figure 11: Result interface after entering data

3.3 Comparison Result Between the Residential Estimated Bill Calculator and TNB's System.

In the comparison phase, the results generated by the residential estimated bill calculator which was developed were compared with the Tenaga Nasional Berhad (TNB) system. Utility billing systems typically need to adhere to regulatory standards and guidelines set by organizations like TNB which was the primary electricity supplier in Malaysia. Based on Figure 12, the loads that were entered by the user consisted fluorescent lamp, ceiling fan, LED television, refrigerator, and LED downlight. Through the calculations from the application, Figure 13 shows the result that displayed a total power consumption was 591.0 kWh per month and the estimated bill was RM 227.16. The calculated power consumption was then entered into the TNB's system to see the estimated bill from this system. Figure 14 shows the result from the TNB's system which was RM 227.16 and the total bill including service tax and ICPT was RM 215.34. It proved that both systems generated the same output for the estimated bills.

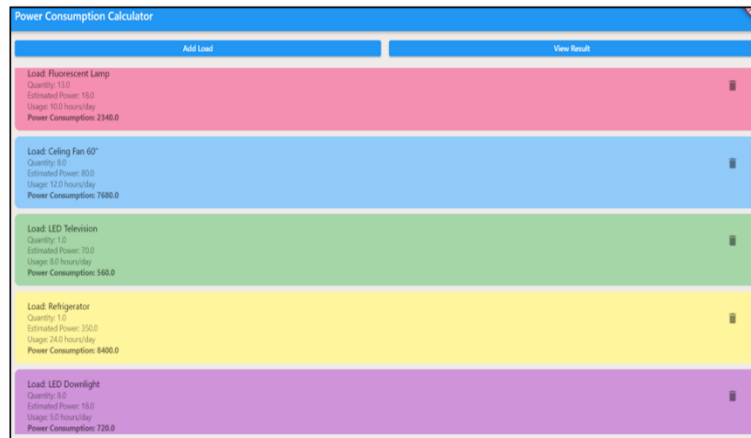


Figure 12: Types of loads entered



Figure 13: Estimated bill result from the application

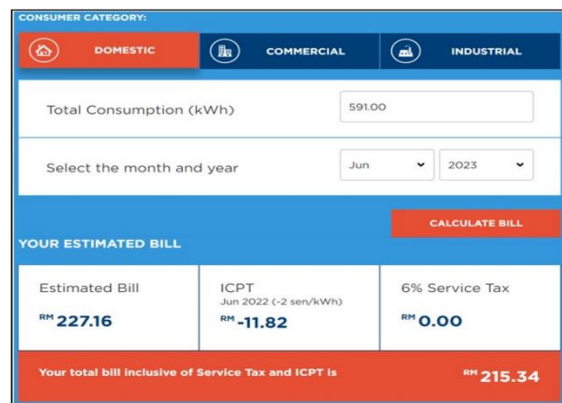


Figure 14: Estimated bill result from TNB's system

4. Conclusion

In general, all the objectives and scope of this project were successfully achieved and met the developer's expectations. However, there was some improvement needed to enhance the system's efficiency. The application was designed to be user-friendly, catering to users of different ages. The system also compared the result with the TNB's system to ensure it showed the accurate desired result. The comparison, shows that the calculation of the estimated bill was tallying with the TNB's system. The weakness of this application was the login interface not included which needed for user to re-enter their data many times. The other weakness was the demand factor (DF) in the total power consumption calculation does not include. It causes the supposed total power consumption in the system 10% less accurate. Overall, the residential estimated bill calculator was 90% accurate and can be used for residents to estimate their bills in a month to help them budget their monthly expenses for utility bills.

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