



Web-Based Budget Estimate Plan (BEP) Application for Electric Lighting Installation

Ade Irawaty Tolago*, Rahmat Deddy Rianto Dako

Electrical Engineering, Engineering Faculty, Universitas Negeri Gorontalo, Gorontalo, Indonesia

*Email: adeirawty@ung.ac.id

ABSTRACT

A good electrical installation must be planned with an accurate cost calculation, so that the budget to be used can be used effectively and efficiently. This budget planning is known as the Budget Estimated Plan (BEP). In general, this BEP can only be done by people who are competent in the electricity sector, so some people cannot make this BEP for electrical installations. Usually, this BEP when made by an electrician always uses the excel program to get the total budget of an installation work. The disadvantage of this excel program is that the maker must enter data on the material requirements needed in the installation. Worse yet, the maker of this BEP has to find the price of the installation materials used and the installation fee, so this requires energy and time in settlement of the BEP. This study aims to develop a web-based application for calculating the cost of lighting installations. The method of this research is Research and Development (R&D) method, which produces a product in the form of an application and tests the effectiveness of the product. The results of the research obtained are in the form of a web-based lighting installation budget calculation application where the point is when making a budget plan using a web-based lighting installation budget calculation application is much more effective, efficient, and does not take too long compared to making it manually. Then, score of usability testing was 76.

Keywords: *BEP, Web-based, Electric Lighting Installations*

1. INTRODUCTION

Electricity is a highly important factor in human life. Almost everyone requires electricity in their daily lives, such as for lighting, household appliances, and more. Whenever a house is built, it is usually accompanied by electrical installation. However, only a few people have a deep understanding of electricity. Therefore, an understanding of electrical installation management is necessary [1]-[3]. In daily life, the need for electrical energy has become a primary necessity for every modern society. Almost every building requires electrical energy that can support human activities, such as homes, schools, offices, and so on. The need for energy that cannot be separated from human daily life is electrical energy, especially for lighting. [4].

In planning electrical installations, in addition to creating a good and clear installation diagram, accurate calculations are also required. If the calculations are still manual, it will take a considerable amount of time and process to achieve accurate results. Therefore, optimization in computer technology is a wise step in helping to solve electrical installation planning. [4] However, in handling it, it is still done manually and using several software such as Microsoft Word and Excel. This causes the time used to be long and

impractical in completing the work. [4] Therefore, a system is needed that can provide information on the cost of electrical installation, so that a satisfying, effective and efficient planning can be obtained. [4].

Budget Estimated Plan (BEP) is one of the main processes in a project, as it serves as the basis for creating a financing system proposal and budget framework that will be issued. Budget planning for a project, as the first step in the cost estimation phase, must be accurate and precise. Budget planning cannot be separated from unit prices of materials, wages, labor, equipment, and time [4].

The function of BEP itself is to provide an overview or price quote to the owner, building contractors, and other stakeholders involved. In addition to the above function, BEP also functions to increase the value of a construction product by reducing waste that occurs through careful calculation, resulting in lean construction. BEP also helps in planning and scheduling, evaluation, and proper control to ensure that construction is completed on time and within budget, preventing uncontrolled expenses and budget overruns [5,6].

The issue that arises after the creation of BEP is that sometimes the building owner is still unsure about the BEP proposed by the contractor whether the BEP is in

accordance with market prices and expected material specifications. To anticipate this, it is necessary to cross-check the prices of materials in the BEP with the market prices of installation materials, and this can take a long time. To avoid such incidents, a program is needed to help lay people view and create BEP for electrical installations.

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Several studies have been conducted regarding the design of BEP, including [4]-[9]. Furthermore, research related to BEP design directly with BEP calculations for electrical installation planning was only carried out by [4] and [7]. Research conducted by [4], the calculation of residential electrical installations is done with a desktop application-based client-server system. Furthermore, [7] designed an expert system application for electrical installation calculations with the Microsoft Office Excel application and the macro module.

Based on these previous studies, this study has similarities in terms of calculating BEP but differs in its implementation. This research focuses on designing applications to calculate BEP for lighting electrical installations with web-based mode.

2. RESEARCH METHODS

The development method of this study uses the Research and Development (R&D) method. The method (R&D) is a type of research that has been widely developed, often interpreted as a process or steps to develop a new product or improve an existing product [10]-[12].

The resulting product is a web-based lighting electrical installation budget estimation plan application. Next, testing the effectiveness of the product is carried out to determine the quality of the product. The developed application is based on the Research and Development model from Borg and Gall. Procedurally there are 6 steps of the R&D model [10]:

a. Research and Information collection

The initial stage is carried out by tracing potential problems and gathering information. The potential problem encountered in this study is how to model the form of the application to be designed so that it can produce a good application product. The initial design of the application form was made by collecting information based on data both from previous studies as

well as documentation and interviews from the authorities involved in the field of electrical installation.

b. Planning

From the previous stage, the application was designed according to the documentation and information obtained. At this stage, the application is designed starting with:

- Designing any actors or application users.
- The interface form of the application.
- Interaction between actors or users with the application interface.
- Data flow from actor to application, or data flow within application.
- Data types and their storage.

c. Develop Preliminary form of Product

In this phase, the development stages of the application will be developed with several tools and web-based programming languages to build the interface and database system. The tools or programming languages that will be used are:

- XAMPP (X stands for cross-platform, A stands for Apache, M stands for MySQL, and PP stands for PHP and Pearl). This application package is used to help local hosts or servers to test websites and their clients through computers and laptops before releasing them to the main server. Apache is a web server application that is free and open source, that is, it can be developed by many people. MySQL is a relational database management system based on the Structured Query Language, which is the popular language for accessing and managing the records in the database [13].
- HTML (Hypertext Markup Language) as the basic foundation of web-based applications [14].
- PHP stands for Hypertext Preprocessor, which is a programming language on the server side [14].
- JavaScript is the programming language of the web [14].

d. Preliminary Field Testing

The process at this stage is to test the features of the application that has been developed whether it is in accordance with the product development goals. The test performed is alpha testing. Alpha testing is end-to-end testing which is the initial testing of a product or application [15]. Alpha testing with the black box method. This black box method is to test the functionality of the features that have been designed whether they work properly or produce errors. In addition, this functionality test is carried out by entering data and then analyzing the results obtained and comparing them with manual calculations, whether they are appropriate or not.

e. Main Product Revision

The process at this stage is to make improvements to features based on the results of alpha testing.

f. Main Field Testing

the process at this stage is re-testing the features that have been revised at the previous stage. The next test is measuring the level of usability and acceptance of the application by users. Testing usability with the System Usability Scale (SUS), because SUS is a quick test method of user acceptance of the computer system or application used [16]. SUS is a questionnaire with 10 statement items. The SUS questionnaire has 5 Likert scale weights. Assessment by respondents can be given by selecting "Strongly Agree", "Agree", "Doubtful", "Disagree", and "Strongly Disagree" [16].

The respondents use SUS , where they have used this application before. An explanation regarding the use of the application before testing is not given. Respondents can give answers in doubt, if the respondent is unable to provide an answer for a statement [16].

Tabel 1. 10 Statement of System Usability Scale (SUS) [16].

No	Statement
1	I think that I would like to use this system frequently
2	I found the system unnecessarily complex
3	I thought the system was easy to use
4	I think that I would need the support of a technical person to be able to use this system
5	I found the various functions in this system were well integrated
6	I thought there was too much inconsistency in this system
7	I would imagine that most people would learn to use this system very quickly
8	I found the system very cumbersome to use
9	I felt very confident using the system
10	I needed to learn a lot of things before I could get going with this system

SUS will produce a value or score which states a combined measure of the overall usability of the system or product being tested [9]. The way to calculate the SUS score is first to add up the contribution scores of each statement. Each statement's contribution score will range from 0 to 4. The contribution scores from Statements 1, 3, 5, 7 and 9 are less than 1 scale position, while the contribution scores of statements 2, 4, 6, 8, and 10 are 5 less scale positions. The sum of all scores is then multiplied by 2.5 to obtain the final score of SUS. The final score of SUS has a range from 0 to 100. The calculation of the SUS score is as follows [16]:

$$\begin{aligned}
 \text{SUS score} = & ((R1 - 1) + (5 - R2) + (R3 - 1) + \\
 & (5 - R4) + (R5 - 1) + (5 - R6) + \\
 & (R7 - 1) + (5 - R8) + (R9 - 1) + \\
 & (5 - R10)) * 2.5 \qquad (1)
 \end{aligned}$$

$$\text{SUS final score} = \frac{\sum(\text{Skor SUS})}{N} \qquad (2)$$

The final SUS score is the average value of the overall SUS score of each respondent (equation 2). The final SUS score obtained can be categorized into the categories of Net Promoter Score (NPS), Acceptability range, Adjective ratings, and Grade scale (figure 1).

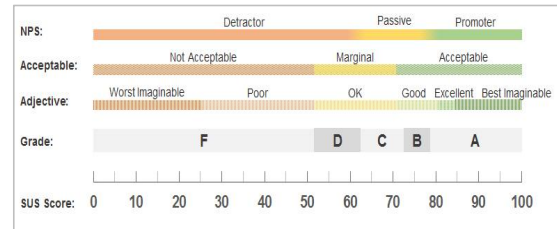


Figure 1 The Relationship between the Final Score of SUS and The NPS Category, Acceptability range, Adjective Ratings and Grade Scale [17].

3. RESULTS AND DISCUSSION

3.1. Results

The product is a Web-Based Budget Estimate Plan (BEP) Application for Electric Lighting Installation. This application can be accessed via the link siringan.my.id.

The interface of the application can be described as follows:

3.1.1. Front page of the application

Figure 2 shows the front page of the application which contains a button to login to the application and a next button to register as a user

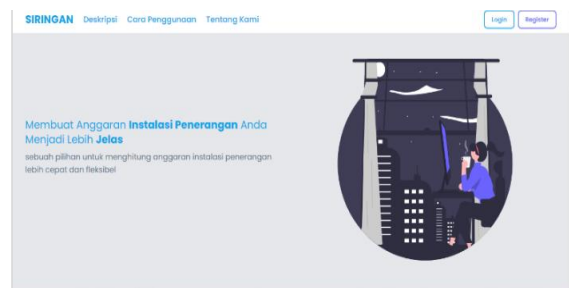


Figure 2 Front Page of Application.

3.1.2. Login form

On this form, admins and users log in by input email and password that they have filled in registration form. This form is shown in figure 3

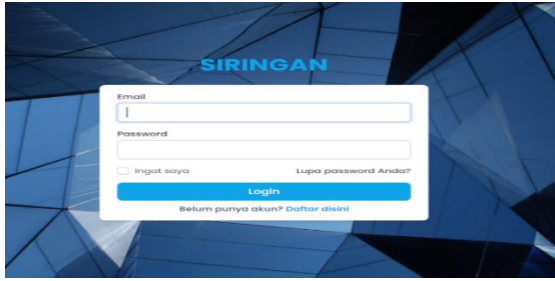


Figure 3 Login Form.

3.1.3. Registration form

the user registers via the registration form so that he can log into the application. the registration form contains a username, email, password, and confirm password, as shown in figure 4

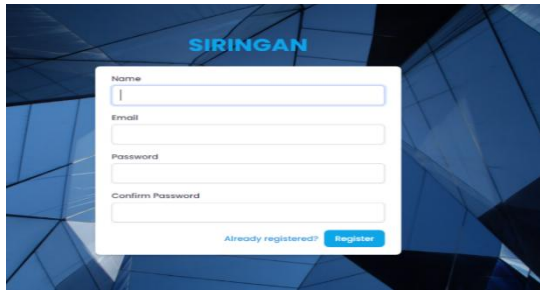


Figure 4 Form Registration.

3.1.4. Main Page

3.1.4.1. Page Item/Goods

Figure 5 is an interface that shows the name, price, unit, wages of an item. This page can only be accessed by the admin which has the function to add and remove things related to the item.

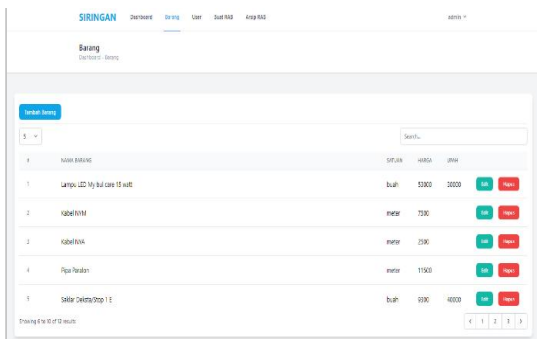


Figure 5 Page Menu Item.

3.1.4.2. Form Edit Items/Goods

Figure 6 shows the item data filling form to change or edit an item you want to change.

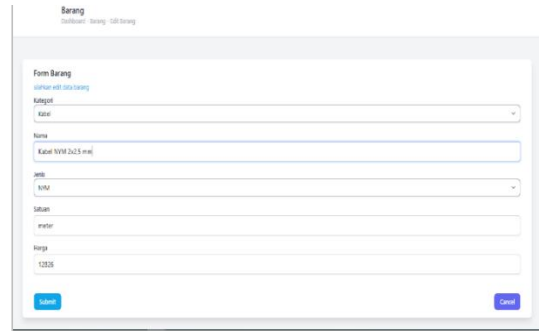


Figure 6 Form to Edit or Change Item/goods.

3.1.4.3. User Page

Figure 7 shows a page that displays user data that has been registered with the application. This page can only be accessed by the admin. the information and features contained on this page are the time when the user logs in and the delete button.

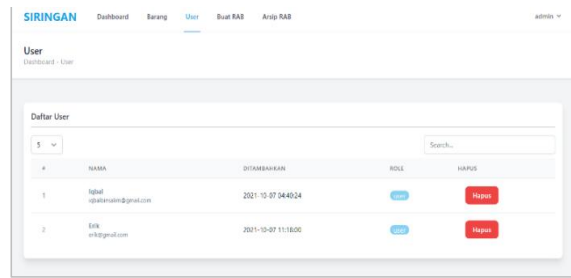


Figure 7 Menu User.

3.1.4.4. BEP Page

On this page, the user must fill in the room data which contains the rooms in the residential house. Next, choose the type of room. after selecting the room type, fill in the length, width, and height of the room. Then, press the *simpan* button to get the BEP results for the lighting installation in that room. The *tambah* button has a function to add the type of room you want to calculate the BEP for lighting installations. this form is shown in figure 8.

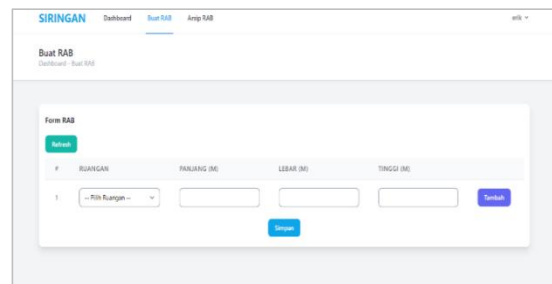


Figure 8 Form to Fill Room Data and Calculate BEP for a Room.

3.1.4.5. Report Page of BEP

Figure 9 displays the BEP report after it is calculated based on the input data of a room. The button *cetak* can be pressed if you want to print this report.

#	BARANG	JUMLAH	SATUAN	HARGA	SUB TOTAL
1	Lampu LED My bul cam 15 watt	2	buah	51000	102000
2	Kabel NIM	6	meter	7500	45000
3	Kabel NIM	2	meter	2500	5000
4	Pipa Plastik	2,75	meter	11000	30250
5	Sekel Deleta	1	buah	7500	7500
6	Pening Deleta	2	buah	5500	11000
Total Harga Barang					201750

Figure 9 BEP Report Page .

3.1.4.6. Salary Page for Worker

Figure 10 displays the output of the calculation results for worker wages for each room

#	BARANG	JUMLAH	SATUAN	SUB TOTAL
1	Lampu LED My bul cam 15 watt	2	buah	102000
2	Sekel Deleta	1	buah	7500
Total Upah				109500

Figure 10 Report Page Salary for Worker.

3.1.4.7. Page of archives

On this page, the results of the BEP summary are stored. This page will be useful if the user wants to review the lighting installation BEP project that has been made. this page is shown by figure 11.

#	TANGGAL	NAMA PROJEK	Status
1	2024-11-08 10:49:23	Kamar Merah	Selesai
2	2024-11-08 10:51:14	Kamar	Selesai
3	2024-11-08 10:52:28	Kamar Merah	Selesai
4	2024-11-08 10:53:28	Kamar Merah	Selesai
5	2024-11-08 10:54:42	Kamar	Selesai
6	2024-11-08 07:48:11	Kamar	Selesai

Figure 11 Page of Archives BEP.

3.1.4.8. Form Edit BEP

Figure 12 shows the BEP edit form that will be displayed if the edit button on the BEP archive page (figure 11) is pressed. Changing the data will be done by changing the room dimension data.

Figure 12 Form Edit BEP

3.1.4.9. Page Detail BEP

Figure 13 displays the BEP Detail form if the detail button on the BEP Archive page (figure 12) is pressed. The information displayed on this page is the BEP calculation results for each room.

#	BARANG	JUMLAH	SATUAN	HARGA	SUB TOTAL
1	Kabel NIM 2x1,5 meter	1,75	meter	17625	30862,5
2	Kabel NIM 2x3 meter	4	meter	4332	17328
3	Pipa Plastik 4,8 inch	2,75	meter	7085	19481,25
4	Sekel Deleta/Clamp 1 0	1	buah	5200	5200
5	Pening Deleta	2	buah	8515	17030
6	Lampu LED My Bul Cam 15 watt	2	buah	38770	77540

Figure 13 Page Detail BEP

3.2. Discussion

Applications that have been successfully designed, then carried out 2 stages of testing. The first stage of testing is to test the features designed with alpha testing. Alpha testing is done with the black box testing model. The results of testing the first stage of this application functionally have given good results and the calculation results report is the same as the results of manual calculations. The second test is to measure the usability level of the application with SUS. Application testing using SUS involved 10 respondents consisting of installers, students and the general public. And the results obtained from the SUS test are as follows:

Table 2. SUS Test Results.

	Count Result Score										Amount	Value (Amount x 2.5)
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10		
1	4	3	3	3	2	2	3	3	3	3	29	73
2	4	3	4	1	4	3	4	3	4	1	31	78
3	4	4	3	3	4	4	3	4	4	1	34	85
4	3	4	4	4	3	2	2	4	4	3	33	83
5	3	3	3	1	3	4	4	3	3	1	28	70
6	3	3	3	1	3	4	4	3	3	1	28	70
7	3	4	4	4	3	2	3	4	4	3	34	85
8	3	3	3	1	3	4	4	3	3	1	28	70
9	3	2	3	3	3	2	2	3	3	0	24	60
10	4	4	3	4	4	3	4	3	3	3	35	88
Total											304	762
Average Score (Final Result)												76

The results of the usability test above show that the result is 762. The next step is to divide 762 by 10 respondents, so that the result is 76. based on the SUS interpretation guidelines, it shows that a score of 76 for acceptability ranges is acceptable, the grade scale results in terms of the level of user acceptance are included in class C, then the adjective ratings version is included in the Good category, and the score obtained is a score that is above the average score (above average).

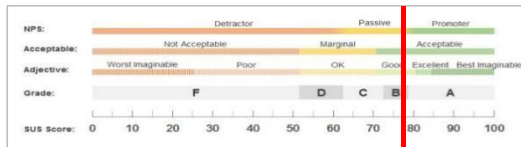


Figure 14 Testing Result with SUS.

4. CONCLUSIONS

Web-based budget estimation plan application has been successfully designed. The results of this design have gone through two stages of testing, namely the alpha testing stage with the black box method and testing the level of user acceptance or usability with the SUS questionnaire. The results of the first test give the result that the application can function properly by looking at the results of the calculations that have been generated. Furthermore, the results of the usability test obtained a final score of 76. Based on four categories, the first is the Acceptability range, which is Acceptable, which states that application is acceptable to users. Second, based on the grade scale, the application gets a B rating. Third, for the adjective ratings category, the application gets the Good category. Fourth, based on the NPS category, the application is classified as passive. This fourth category indicates that the application is in between recommended and not. So, as a whole it can be concluded that the application meets the usability criteria and can be accepted based on user perceptions. However, with these results it is also necessary to conduct a review for development and improvement in further applications, because the results obtained have not achieved the best results based on SUS.

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