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An Prototype: Mobile based Fire Extinguisher Count Requirement System

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Abstract

It is possible to make an effort to meet active fire protection standards by having fire extinguishers available, which refer to the rules for the number of requirements and placement of fire extinguishers in each building. These rules can be found in the active fire protection standards document. Formulas are used in accordance with the Regulation of the Minister of Manpower and Transmigration No. Per.04 / MEN / 1980 in order to determine how many fire extinguishers are required for a given location. Currently, the problem that occurs is that there are still many buildings that have not met active fire protection standards such as not matching the number of fire extinguisher needs and their placement in a building. Data collection is carried out with two approaches to qualitative and quantitative methods. It was found that the prototype of the system that was built can be understood by users very well, and that the level of usability has met good results based on the SUS method. These findings were based on the findings of tests that evaluated the system's effectiveness and efficiency. It is anticipated that this prototype system will contribute to efforts in active fire protection.

Keywords: Fire Extinguisher, SUS, Count, APAR.

1 Introduction

Fire is an oxidation event with the meeting of three elements of fire, namely combustible materials, oxygen contained in the air, and heat. Fire can have a major impact on humans such as property loss, injury, to death [1], [2]. Based on observations and tracing of fire data in Indonesia, it was found that there are still many buildings that experience fires caused by non-conformity of the active fire protection system applied. An active fire protection system is a complete fire protection system consisting of both manual and automatic fire detection systems, water-based fire suppression systems such as sprinklers, standpipes and fire hoses, and chemical-based fire suppression systems, such as fire extinguishers and special extinguishers [3], [4].

According to [5] one of the efforts to overcome the high risk of fire that occurs, an effort is needed to meet active fire protection standards. One of the fire extinguisher equipment that must be present in a building is a Light Fire Extinguisher (APAR). APAR is an extinguisher that can be transported, lifted, and operated by one person. APAR has an important role for fire prevention and suppression when a fire occurs in a building. APAR can be one of the tools required in a building and become part of the standardization of active fire protection in buildings that are self-contained (systems that are able to overcome fires that occur) [6].

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Efforts to meet active fire protection standards can be done with the availability of fire extinguishers which refer to the rules for the number of fire extinguishers needed and the placement of fire extinguishers in each building. The calculation of fire extinguisher needs is based on the Regulation of the Minister of Manpower and Transmigration No. Per.04 / MEN / 1980 with a certain formula. Currently, the problem that occurs is that there are still many buildings that do not meet active fire protection standards such as the number of fire extinguisher needs and their placement in a building. Based on this description, the fulfillment of active fire protection standards in buildings needs to be met through a system that can calculate fire extinguisher needs and their placement. The use of Information Technology in the form of an android-based system is expected to help meet active fire protection standards through the calculation and placement of fire extinguishers practically for organizations. In addition, the development of the android-based system will use the Systems Development Life Cycle (SDLC) with the Prototype method [7] with the aim that the system can be used according to user needs.

2 Research Method

2.1 System Developing Overview

The flow of this stage can also be thought of as a state of mind throughout this research. The first step is to provide a description of the level of significance of either the issue being addressed or the study being conducted. This research needs to be done as quickly as possible so that efforts can be made to improve active fire protection. In addition, the description of the urgency will serve as the basis for the identification of research difficulties, including the requirement of a method for determining the requirements and positioning of android-based fire extinguishers as part of an active fire prevention effort in buildings. The following step will be to collect information and conduct a research literature analysis in order to locate relevant theories and previous research that can serve as the basis for this research. The next step, which is carried out after gathering relevant theories and research, is to identify the topic and scope of the research that will be done. The concept and the scope of this research include the following processes or stages, ranging from collecting system needs data using a qualitative approach, to developing a system using SDLC-Prototype, to quantitatively evaluating a system by adopting the Systems Usability Scale (SUS) model as a research instrument, and finally drawing conclusions to determine whether or not the research that was carried out can answer the existing problem formulation.

2.2 Prototyping Model

System development techniques using Systems Development Life Cycle (SDLC) – Prototype. The stages carried out are [7]:

1) Analysis. At this stage the developer identifies the software and all the system needs to be created.
2) Create a prototype. Create a temporary design that focuses on the flow of the program to users.
3) Evaluate the prototype. Evaluation is carried out to find out whether the prototype model is in accordance with expectations.

2.3 Data Collection and Analysis

Data collection is carried out with two approaches: qualitative and quantitative methods. The qualitative approach is related to data collection in accordance with the Regulation of the Minister of Manpower and Transmigration No. Per.04/MEN/1980. The data obtained through this qualitative method will be the basis for development.

This mobile-based fire extinguisher requirement calculation technology will be tested based on effectiveness and efficiency testing, as well as system usability testing. Meanwhile, the sampling technique of both stages will use the principle of Purposive Sampling. The number of samples determined was as many as 30 respondents. Meanwhile, data collection with a quantitative approach is carried out after the development of a system prototype through the implementation of task scenarios on effectiveness and efficiency testing and questionnaires using SUS. The collected quantitative data then enters the analysis process based on the provisions of the SUS method.

3 Research Method

3.1 Analysis

System development begins with an analysis of system requirements. This aims to prepare various system needs including the necessary tools, information presented by the system, to the initial system design process. Development of android-based systems using the Flutter programming language. In addition, this system will apply the APAR calculation formula based on the Regulation of the Minister of Manpower and Transmigration No. Per.04/MEN/1980.

3.2 Creating Prototype

At this stage, a temporary design is carried out that focuses on the flow of the program to users. In general, the planned program flow is as follows.

1) User (user) can install on an android smartphone.
2) The user opens the fire extinguisher calculation and placement system.
3) On the initial menu, the system displays the area of the building that must be inputted. Then, the user must select the available fire extinguisher type options.
4) The system will display the number of fire extinguisher needs that must be provided based on the area of the building inputted. Meanwhile, the resulting output can be downloaded.
5) On the fire extinguisher needs results menu, users can determine the placement of fire extinguishers.

The system will display the distance of fire extinguisher placement according to the regulations used. Meanwhile, those outputs can also be downloaded. Prototype display show in Figure 1 to 5.

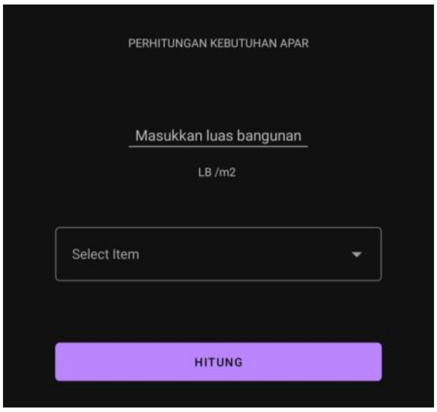

Figure 1: Prototype 1

This page is the initial display when entering and consists of building area input and input of the type of apparatus you want to use as in Figure 2 and 3.

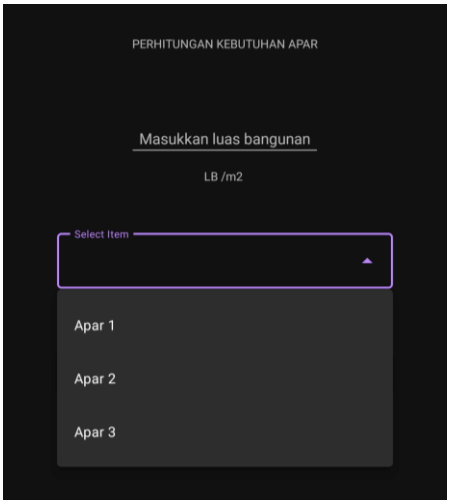

Figure 2: Prototype 2

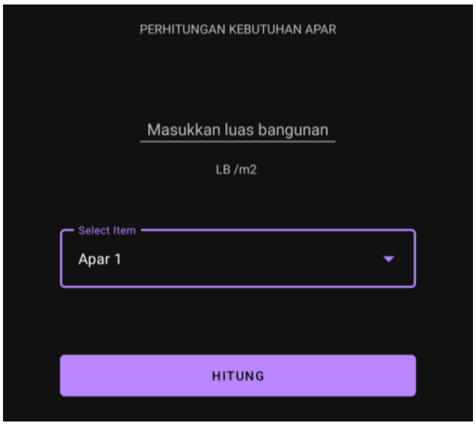

Figure 3: Prototype 3

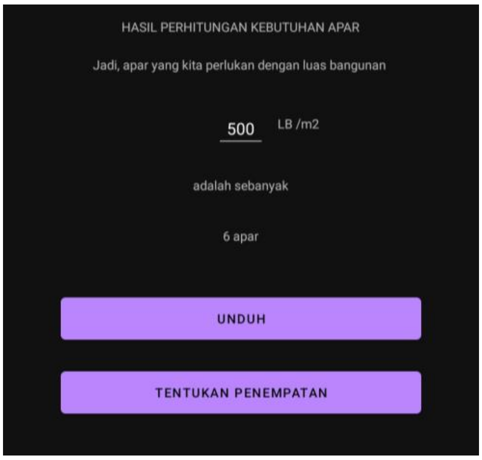

Figure 4: Prototype 4

Figures 4 and 5 present the findings of the fire extinguisher tests that need to be performed in the buildings that have been evaluated in the region. This display also includes a feature that can determine the distance between tools, and the results may be downloaded. Additionally, this display also supports downloading the results.

Figure 5: Prototyping 5

3.3 Evaluation

Prototype model is in accordance with user expectations in solving problems. In this study, there were 2 test designs, namely the first test (effectiveness and efficiency) and the second test (usability). Effectiveness testing relates to success in meeting user needs and ease of use [8]–[10]. Meanwhile, efficiency testing relates to the time required to meet the scenario of the researcher while testing [10], [11]. The design scenarios that respondents must run in testing effectiveness and efficiency are presented in the Table 1.

Table 1: Scenario Testing

Task	Scenario	Time (second)
Task I	Respondents were asked to install the Fire Extinguisher Calculation and Placement System	240
Task II	Respondents were asked to open the APAR Calculation and Placement System that had been installed	10

Task III	Respondents were asked to input the Building Area for the calculation of fire extinguisher	10
Task IV	Respondents were asked to choose the fire extinguisher type option for the calculation of fire extinguisher	10
Task V	Respondents were asked to download the results of the fire extinguisher calculation	10
Task VI	Respondents were asked to know the placement of fire extinguishers	10
Task VII	Respondents were asked to download the results of fire extinguisher placement	10

Table 1 determine the User Task as many as 7 scenarios that must be carried out by respondents [12]. The next test is system usability testing using the SUS questionnaire. System Usability Scale (SUS) is a measurement of user satisfaction by distributing a simple questionnaire to users after carrying out an existing task scenario. This questionnaire consists of 10 basic questions to measure the level of user satisfaction [13], [14] with the fire extinguisher calculation and placement system.

1) I'm thinking of using this system again.
2) I feel that this system is complicated to use.
3) I feel that this system is easy to use.
4) I need help from other people or technicians in using this system.
5) I feel that the features of this system are working properly.
6) I feel that there are a lot of things that are inconsistent (mismatched in this system).
7) I feel that others will understand how to use this system quickly.
8) I find this system confusing.
9) I feel that there is no obstacle in using this system.
10) I need to familiarize myself first before using this system.

4 Result

4.1 Evaluation Result

The first test, namely effectiveness and efficiency, was carried out on 30 respondents. The test results are presented in the Table 2.

Table 2: Effectiveness testing

Task	Scenario	Errors numbers	Errors percentage
Task I	Respondents were asked to install the Fire Extinguisher Calculation and Placement System	0	0
Task II	Respondents were asked to open the APAR Calculation and Placement System that had been installed	0	0

Task	Scenario	Errors numbers	Errors percentage
Task III	Respondents were asked to input the Building Area for the calculation of fire extinguisher	0	0
Task IV	Respondents were asked to choose the fire extinguisher type option for the calculation of fire extinguisher	0	0
Task V	Respondents were asked to download the results of the fire extinguisher calculation	2	6.7
Task VI	Respondents were asked to know the placement of fire extinguishers	0	0
Task VII	Respondents were asked to download the results of fire extinguisher placement	1	3,3

Based on the Table 2, it can be seen that the system can be used easily and understood by users when running scenario tasks based on aspects of effectiveness. However, there are still a few errors, especially in 2 types of tasks, namely "Respondents are asked to download the results of APAR calculations" and "Respondents are asked to download APAR placement results". Based on testing aspects of effectiveness, it can be said that the prototype system built is effective for users. Measurement of efficiency aspects is calculated by looking at the time needed to carry out the tasks performed. These measurements can be seen in the Table 3.

Table 3: Efficiency testing

Task	Scenario	Time (seconds)	Time average by Respondent (seconds)
Task I	Respondents were asked to install the Fire Extinguisher Calculation and Placement System	240	200
Task II	Respondents were asked to open the APAR Calculation and Placement System that had been installed	10	8
Task III	Respondents were asked to input the Building Area for the calculation of fire extinguisher	10	6
Task IV	Respondents were asked to choose the fire extinguisher type option for the calculation of fire extinguisher	10	6
Task V	Respondents were asked to download the results of the fire extinguisher calculation	10	8
Task VI	Respondents were asked to know the placement of fire extinguishers	10	5
Task VII	Respondents were asked to download the results of fire extinguisher placement	10	7

Based on the efficiency testing table of the system prototype above, it can be concluded that the average respondent in taking the given task scenario does not exceed the predetermined time limit. This means that the prototype system built has shown good efficiency for users. Based on the first test, namely assessing the effectiveness and efficiency of the system built, it was found that the system did not make it difficult for users to achieve the research objectives that had been set. Because the prototype system built is the initial effort to meet active fire protection standards in a technology-based building.

The next test is to measure the level of usability of the system built or usability using SUS. Analysis of questionnaire data with SUS Questionnaire uses a formula that has been set in SUS as in Formula 1 with several rules, namely [15]:

1) Odd statements, namely: 1, 3, 5, 7, and 9 scores given by respondents minus 1.
2) Even statements, i.e. 2, 4, 6, 8, and 10 scores given by respondents are used to subtract 5.
3) The results of the conversion are then added for each respondent then multiplied by 2.5 to get a range of values between 0 – 100.
4) After the scores of each respondent have been known, the next step is to find the average score by summing all the score results and dividing by the number of existing respondents. This calculation will use formula 1 written earlier.

The rules for calculating the value apply to 1 respondent. For the overall analysis of respondents, it will be analyzed based on the average of all respondents. After getting the final average result, the value will be adjusted with the SUS provisions as shown below.

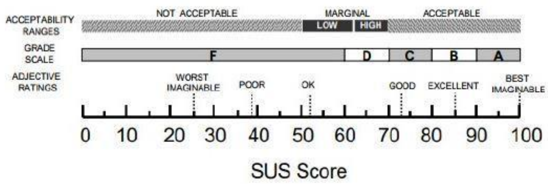

Figure 6: SUS Score Adoption

In this second test, respondents were asked to answer all statements adopted from the SUS questionnaire. The number of respondents in this test is the same as before, which is 30 people. The recapitulation of the data obtained from respondents is presented in the Table 4.

Table 4: Data collection

Score									
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
5	1	5	1	5	2	5	1	4	1
5	3	5	3	5	3	5	3	3	3
4	2	4	2	3	2	3	2	4	2
5	3	5	3	5	2	5	3	5	3
4	2	4	2	4	2	4	2	4	2
5	2	4	2	5	1	5	2	5	2
4	2	5	2	5	2	5	2	3	2
5	2	5	2	5	3	5	2	3	2
4	2	4	2	5	3	5	2	4	2
3	3	5	3	3	2	3	1	3	3
4	2	4	2	4	3	4	2	4	2

Score									
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
4	2	4	2	4	3	4	2	4	1
5	1	5	1	5	1	5	1	4	1
4	2	4	2	5	2	5	2	4	2
4	2	4	2	4	2	4	2	4	2
5	1	5	1	4	1	4	1	4	1
4	2	4	2	5	2	5	2	4	2
5	2	5	2	5	1	5	2	4	2
5	1	5	1	4	2	4	3	4	3
5	2	5	2	4	2	4	2	4	2
5	2	5	1	5	3	4	2	4	1
4	1	5	1	4	2	3	1	5	1
5	1	4	1	4	2	5	2	4	1
4	1	5	2	4	2	5	1	5	1
5	2	4	3	5	1	4	2	4	1
5	1	5	2	5	1	5	1	5	1
4	1	4	2	5	3	5	1	4	2
4	1	5	2	4	1	4	1	5	2
5	1	4	1	4	1	5	1	5	1
4	1	5	1	5	1	5	2	4	1

In the table above it can be seen that the recapitulation of data from the second test of 30 respondents. Furthermore, the data will be calculated based on the rules of the SUS method so that an average value for system evaluation is obtained. The calculation of the score can be seen in the following Table 5.

Table 5: Data Analysis

Measure Score										Sum	Score
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10		
4	4	4	4	4	3	4	4	3	4	38	95
4	2	4	2	4	2	4	2	2	2	28	70
3	3	3	3	2	3	2	3	3	3	28	70
4	2	4	2	4	3	4	2	4	2	31	78
3	3	3	3	3	3	3	3	3	3	30	75
4	3	3	3	4	4	4	3	4	3	35	88
3	3	4	3	4	3	4	3	2	3	32	80
4	3	4	3	4	2	4	3	2	3	32	80
3	3	3	3	4	2	4	3	3	3	31	78
2	2	4	2	2	3	2	4	2	2	25	63
3	3	3	3	3	2	3	3	3	3	29	73
3	3	3	3	3	2	3	3	3	4	30	75
4	4	4	4	4	4	4	4	3	4	39	98

Measure Score										Sum	Score
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10		
3	3	3	3	4	3	4	3	3	3	32	80
3	3	3	3	3	3	3	3	3	3	30	75
4	4	4	4	3	4	3	4	3	4	37	93
3	3	3	3	4	3	4	3	3	3	32	80
4	3	4	3	4	4	4	3	3	3	35	88
4	4	4	4	3	3	3	2	3	2	32	80
4	3	4	3	3	3	3	3	3	3	32	80
4	3	4	4	4	2	3	3	3	4	34	85
3	4	4	4	3	3	2	4	4	4	35	88
4	4	3	4	3	3	4	3	3	4	35	88
3	4	4	3	3	3	4	4	4	4	36	90
4	3	3	2	4	4	3	3	3	4	33	83
4	4	4	3	4	4	4	4	4	4	39	98
3	4	3	3	4	2	4	4	3	3	33	83
3	4	4	3	3	4	3	4	4	3	35	88
4	4	3	4	3	4	4	4	4	4	38	95
3	4	4	4	4	4	4	3	3	4	37	93

Based on the score calculation, it was found that the average score or final result of the alternative design prototype was 80. This means that the score is included in the EXCELLENT category with a grade scale B [16]. This means that usability based on the data gets a satisfactory or decent assessment, so that the prototype system built is considered good enough.

5 Conclusion

Based on the research objectives, problem formulation, and research implementation, it was found that the development of a prototype of the fire extinguisher calculation system and placement was successfully built. In addition, based on the results of effectiveness and efficiency testing, it was found that the prototype system built can be understood by users well, and the level of usability has met good results based on the SUS method. The prototype of this system is expected to be an effort in active fire protection in buildings in accordance with the Regulation of the Minister of Manpower and Transmigration No. Per.04 / MEN / 1980.

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