

Android-Based Inspection and Testing Analytical System of Electrical Safety

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Abstract

The process of inspection and testing of electrical safety nowadays is commonly done manually. This method has many weaknesses, one of them is the analysis result needs longer time and less accuracy. To overcome this problem, it needs an information system to inspect and to test the effectiveness of electrical safety. The purpose of this research is to design an android-based application which has function to become a tool to make electrical safety inspection and testing much easier. The parameter that will be used is administration documents checking, assessment, measurement, calculation, and testing. The android operation system is used to fasten the work process and get output that meet safety requirements. Black Box method is used to test the app and expected to fulfill the expectation and meet the goal. The result of this paper is that the app shows android-based inspection and testing system for electrical safety can be recommended for faster and accurate report.

Keywords : *inspection and testing, black bock method, android*

1. Introduction

An electrical hazard possibly caused an incident in work place [1][2][3]. One of way to prevent and reduce the danger is implementation the electrical safey inspection and testing in the workplace [4][5][6]. The problem that exists in electrical safety inspection nowadays is the inspection is manually with the administration document checking, visual assessment, measurement, calculation, and testing. Those activities are done using checklist paper and testing, then the result has to be proceeded at home to analyze and finally make the report. In the process, the making of report needs a longer time to finish because the data are many. Moreover, the process of documentation and reporting is done manually so there is a risk of data loss and obstruct the result. The reviewer also needs longer time to decide that the equipment is meet safety requirements or not. This caused the company not immediately doing the preventive action on electrical hazard so it creates potency of incident.

The solution of this problem is making an android based information system to inspect and test the electrical safety that can be used to give work check instructions that fulfill the electrical standard which are administration document checking, visual assessment, measurement, calculation, and testing [9][10]. With this application, the inspector can easily analyze the result and arrange the report because on the application, there are the reference of electrical standard, photo menus, note-finding menus, and recommendations. Then the report of inspection and testing can be easily delivered through internet to the companies, consultants, governments, and the others.

Inspection and Testing Electrical Safety

Inspection and testing electrical safety is an activity of evaluating, measuring, assessment, and calculating the electrical tools, equipment, and installation to ensure the qualification in electrical accordance to government regulations. The electrical safety inspection and testing is compulsory, starting on planning, installing, using, changing, and maintenance the electrical generating system, transmission, distribution, and utilization. The purposes of electrical safety are to ensure there is no electrical hazard in the workplace that can cause danger for workers, to ensure the safety of electrical installation, and give building safety and all the components inside and then to ensure the safeness and healthiness workplace and increase productivities.

The Manual Method of Electrical Safety Inspection and Testing

The method of electrical safety inspection and testing is explained in Table 1.

Table 1. The Manual Method of Electrical Safety Inspection and Testing [4][5]

No	Input	Activities	Tools and Materials	Output process	Duration
1.	Administration document checking	Checking the manual book/data sheet, electrical installation pictures, symbols, and safety signs.	<ul style="list-style-type: none"> - Measuring instruments - Checklist paper - Personal Protective equipments 	The manual report of electrical safety inspection and testing.	1 (one) month
2.	Assessment	Inspection the equipment conditions, tools, and electrical installation installed according to standard.			
3.	Measurement	Investigating the electrical measurement with the standard			
4.	Calculation	Comparing the electrical quality and quantity with the standard			
5.	Testing	Testing the electrical system equipment, tools, and installation individually.			

Android-Based Electrical Safety Inspection and Testing (Digital Method)

The android based electrical safety inspection and testing explained below.

Table 2. Android-Based Electrical Safety Inspection and Testing (Digital Method) [4][9]

No	Input	Activities	Tools and Materials	Output process	Duration
1.	Administration document checking	Checking the manual book/data sheet, electrical installation pictures, symbols, and safety signs.	<ul style="list-style-type: none"> - Measuring instruments - Android smartphone - Personal Protective equipments 	The digital report of electrical safety inspection and testing.	1 (one) day
2.	Assessment	Inspection the equipment conditions, tools, and electrical installation installed according to standard.			
3.	Measurement	Investigating the electrical measurement with the standard.			
4.	Calculation	Comparing the electrical quality and quantity with the standard.			
5.	Testing	Testing the electrical system equipment, tools, and installation individually with app system.			

2. Research Proposed Method

The model analysis is applied on electricity distribution and utilization system [11][12][13][14]. The activity started with inspection and testing electrical safety manually. Next, the researcher takes the checklist data of electrical safety inspection and testing, electrical score and standard value, form and report documents. Those data are used to design and to develop a software application, so that become an android based electrical safety inspection and testing. The research design is presented in Figure 1.

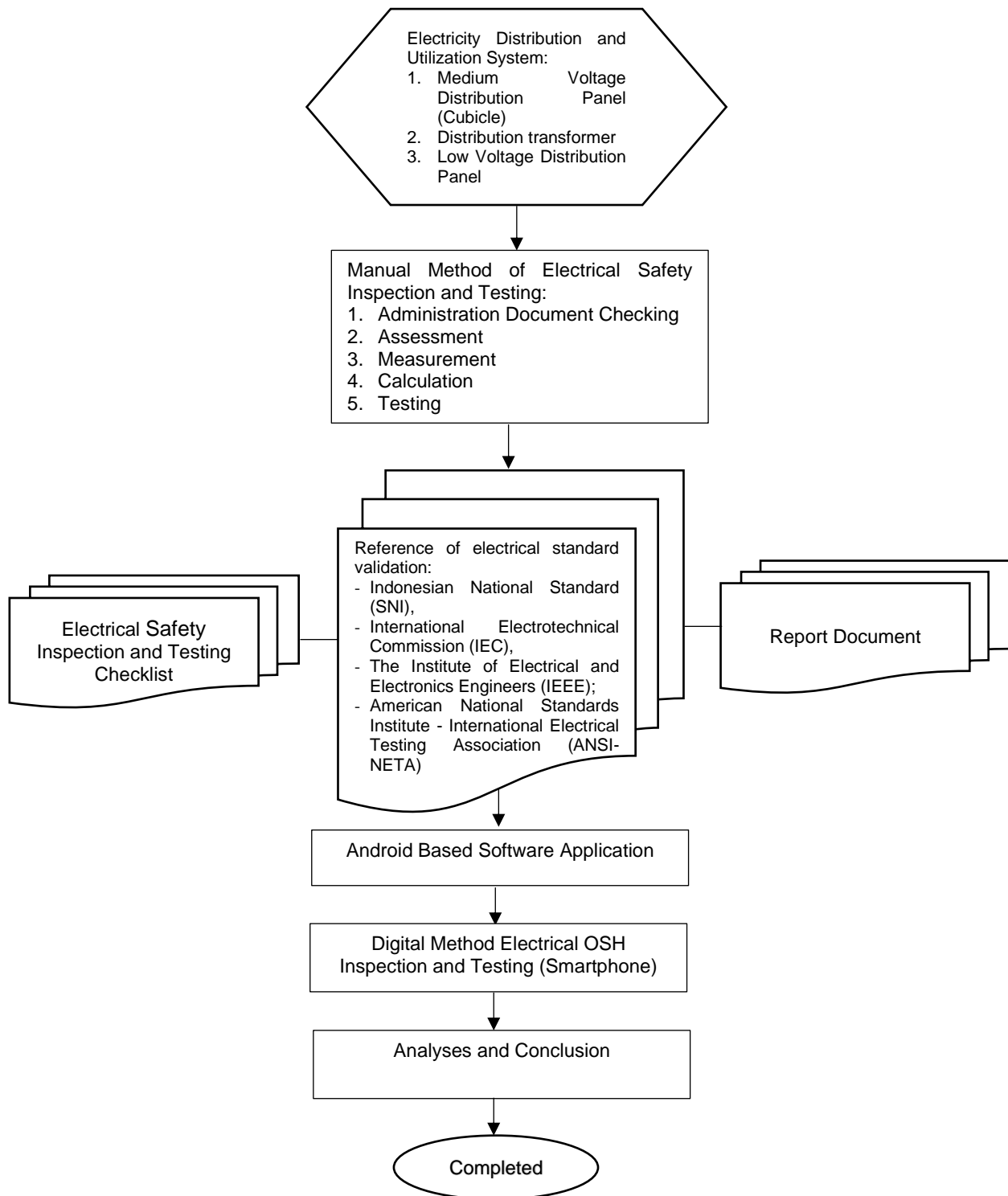


Figure 1. Analysis System Model [4][11]

Literature Review

The literature reviews in this research are presented as follow:

- a. The researcher scrutinized the process of electrical safety inspection and testing.
- b. The researcher scrutinized the standard of the electrical safety inspection and testing [7][8][15].
- c. The researcher scrutinized the value of electrical safety testing and inspection from the electrical standards [16][17][18].

- d. The researcher investigated the documentation and reports of electrical safety inspection and testing results.
- e. The researcher learned the introduction of information system specifically database system and MySQL [19][20].
- f. The researcher studied about android application system.

Field Studies

The researcher is doing the field study of electricity distribution and utilization system in X manufactory. The activities are:

- a. Identified the activities of electrical safety inspection and testing in electricity distribution and utilization system.
- b. Identified the process of electrical safety inspection and testing in electricity distribution and utilization system.
- c. Identified the electrical equipment and tools in the electricity distribution and utilization system.
- d. Investigated the electrical safety form and document reports.

Data Collection Technique

The data collection technique in this research are:

- a. The checklist paper of electrical safety inspection and testing on the electricity distribution and utilization system.
- b. The standard that regulates the checking and testing electrical safety on the electricity distribution and utilization system.
- c. Making an electrical safety inspection and testing report.

Software Arrangement

The software arrangement is done with several programs which are Delphi, Android Studio, MySQL, Pascal and Java. Delphi and Android Studio are used to arrange the application. MySQL is used to arrange the database. Whereas the programming language is arranged using Pascal and Java. Before the program are used, the designer provides flowcharts and app mockups. The flowcharts that used are Iain Entity Relationship Diagram, Data flow Diagram, dan System Interface Diagram [9][10].

The software arrangement is using waterfall method that presented in Figure 2, where the progress is flowing to down (like a waterfall), pass through the arrangement, designing, implementation (construction), and testing. On the process, the waterfall method has several coherent stages: requirement (analysis of requirement), system design, coding and testing, program implementation and maintenance[21][22].

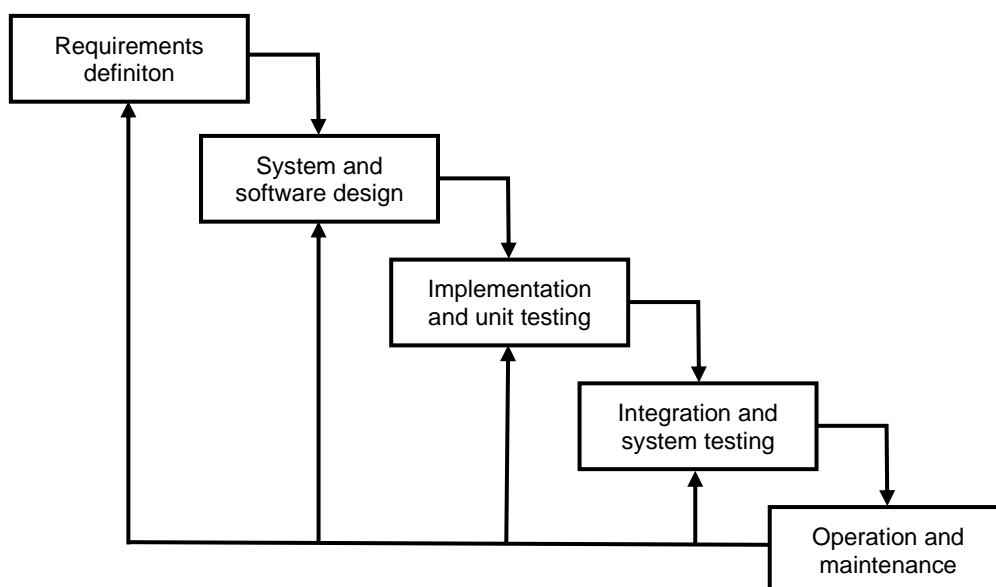


Figure 2. Waterfall Method [21][22]

a. Requirement (Analysis of Requirement)

The data is collected through the collection of checklist paper on electricity distribution and utilization system, the standard validation of electrical safety, inspection and testing system report making [8][15][23]. The example of electrical safety checklist paper and standard validation on electrical distribution is presented in Table 3.

Table 3. Checklist of Electrical Safety Inspection and Testing, and Reference Value of Electrical Standard Validation

A. Administration Document Checking

NO	OBJECT	STANDARD	VALIDATION VALUE ELECTRICAL STANDARD
1.	Situation Diagram	SNI; IEC; IEEE; ANSI-NETA	Well available and safe for installation, maintenance and utilization activity.
2.	Single Line Diagram (SLD) completed with nominal amount	SNI; IEC; IEEE; ANSI-NETA	Well available and installed in distribution panel and safe for installation activity, maintenance and utilization
3.	Installation Diagram	SNI; IEC; IEEE; ANSI-NETA	Well available and safe for installation, maintenance and utilization activity.
<i>Et cetera</i>			

B. Assessment

NO	OBJECT	STANDARD	VALIDATION VALUE ELECTRICAL STANDARD
1.	Equipment data sign with picture and Transformer Distribution specification	SNI; IEC; IEEE; ANSI-NETA	Solidly installed and the data is clearly read in transformer's body to identify the transformer's specification
2.	Transformer Physical Cleanliness	SNI; IEC; IEEE; ANSI-NETA	Clean and free from dirt, dust, dust and carbon formed
3.	Bushing Physical Cleanliness	SNI; IEC; IEEE; ANSI-NETA	Clean and free from dirt, dust, dust and carbon formed
<i>Et cetera</i>			

C. Measurement

NO	OBJECT	STANDARD	VALIDATION VALUE ELECTRICAL STANDARD
1.	R Phase Current Measurement (I _r); S Phase Current (I _s); T Phase Current (I _t) Section Secondary Distribution Transformer;	SNI; IEC; IEEE; ANSI-NETA	Equally measured, so to cause overheating in one of the phase conductors which results in reduced quality of insulation resistance
2.	Measurement of the Neutral Conductor Current (I _n) the Secondary Part of the Distribution Transformer;	SNI; IEC; IEEE; ANSI-NETA	Neutral current must be small to reduce power losses
3.	Pengukuran Arus Penghantar PE (I _{pe}) bagian Skunder Trafo Distribusi;	SNI; IEC; IEEE; ANSI-NETA	The PE delivery must be small to reduce power losses
<i>Et cetera</i>			

D. Calculation

NO	OBJECT	STANDARD	VALIDATION VALUE ELECTRICAL STANDARD
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1.	Calculation of distribution transformer output conductor rating	SNI; IEC; IEEE; ANSI-NETA :	Rating KHA (Current Conducting Capacity) distribution transformer output conductor must be $\geq 125 \% \times I_n$ (load current) to protect potential arc hazards and blast.
2.	Calculation of distribution transformer main protection rating	SNI; IEC; IEEE; ANSI-NETA :	The main protection rating of the Distribution Transformer is $\leq 100\% \times I_{fl}$ (full load current of the transformer) to protect against potential arc fire and blast hazards.
3.	Calculation of imbalance distribution transformer load	SNI, IEC : IEEE: ANSI-NETA:	The percentage of unbalance current (load) is $\leq 5 \%$ to control the potential danger of overheating and power losses
Et cetera			

E. Testing

NO	OBJECT	STANDARD	VALIDATION VALUE ELECTRICAL STANDARD
1.	Testing on distribution transformer main protection	SNI; IEC; IEEE; ANSI-NETA :	Working normally
2.	Voltage Drop Trip Test	SNI; IEC; IEEE; ANSI-NETA :	Working normally
3.	Protection Relay Test	SNI; IEC; IEEE; ANSI-NETA :	Working normally
Et cetera			

The example of electrical safety inspection and testing system result is presented in Table 4.

Table 4 Electrical Safety Inspection and Testing Distribution Report

1. GENERAL DATA

1	Owner	THE WUJIL RESORT & CONVENTIONS
2	Location	Jl. Soekarno Hatta Setiggen, Wujil, Bergas, Kab. Semarang
3	Date of Inspection	April 23 2021
4	Inspected by	NASHRUDDIN ANWAR, ST
5	No. Of Report	016/IL/NAA/IV/2021
6	References	a. Indonesian National Standard (SNI), b. International Electrotechnical Commission (IEC), c. The Institute of Electrical and Electronics Engineers (IEEE); d. American National Standards Institute - International Electrical Testing Association (ANSI-NETA)

2. TECHNICAL DATA

1	Electrical Type	Distribution
2	Electrical Power Capacity	630 kVA
3	Voltage	400/230 V
4	Frequency	50 Hz

3. INSPECTION AND TESTING RESULT

A. Administration Document Checking

1	Situation Diagram	Well available and safe for installation, maintenance and utilization activity.	Meet safety requirements
2	Single Line Diagram (SLD) completed with nominal amount	Well available and installed in distribution panel and safe for installation activity, maintenance and utilization.	Meet safety requirements
3	Installation picture of surveillance diagram	Well available and safe for installation, maintenance and utilization activity.	Does not meet safety requirements
4	Manufacturer's certificate	Well available and safe for installation, maintenance and utilization activity.	Meet safety requirements
5	Manual Book	Well available and safe for installation, maintenance and utilization activity.	Meet safety requirements
Et Cetera			

b. System Design

This process is focused on the data structure, software design, interface representation, and procedure details that consist of:

- The arrangement of software application that consist of making entity relationship flowchart, data flow chart, and system interface diagram.
- The application arrangement is the process or making the application.
- The making of the app mock-up.
- The arrangement of interface or app display.
- The arrangement of electrical safety database inspection and testing.
- App coding.

c. Coding & Testing

Coding is the activity of data transfer to the computer language. This activity is done by the programmer. This stage is the real stage which has been done in the system. The use of computer is being maximized in this stage. After the coding is done, the system needs to be tested. The purpose of the testing is to find the system flaws and repair it.

d. Integration & Testing Program

This stage, can be said is the final of the system arrangement. After the analyses of design and coding is done, the system can be used by user.

e. Maintenance (Operation & Maintenance)

The software that difficult to be delivered to the user is definitely needed to be changed. The changing can be caused of the software lack of adaptation (peripheral or new operation system), or because the user needs a functional development.

Android App Arrangement

The arranged app has two login functions: administrator and user. The login administrator function is to input object items of electrical equipment and tools that will be tested, to set the inspection and testing parameter standard, and give a inspection and testing guidance, and access the inspection reports. Whereas login user that operated by electrical safety tester has function to fill the company data form, checking the technical data that consist of company general form, technical checking form, and testing form that consist of administration document checking, assessment, measurement, calculation, testing, photo upload, and fill the repair recommendation. After doing the inspection and testing data fulfillment, the user can access the complete report of checking and testing form.

The process of app arrangements are presented as follow:

- a. User (Tester) determines the inspection and testing electrical safety object.
- b. User (Tester) determines the inspection and testing types, fill the serial number, dates and tester name.
- c. User (Tester) fills the company general data.

- d. User (Tester) inspection and testing through check list that consists of administration documents, assessment, measurement, calculation and testing.
- e. User (Tester) inputs image data.
- f. User (Tester) inputs recommendation data.
- g. User (Tester) doing saving data.
- h. User (Tester) print the electrical OSH inspection and testing report.

Research Design

The research design on android based electrical safety inspection and testing system is presented in Figure 3.

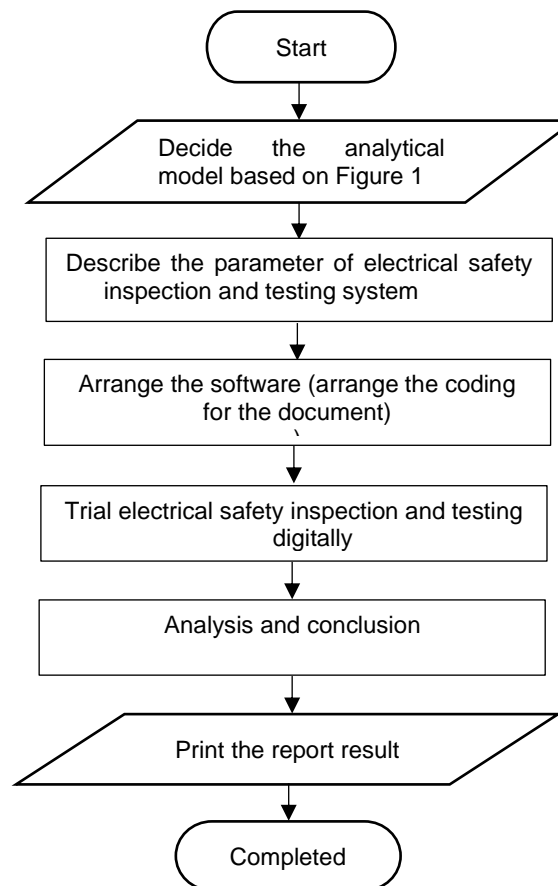


Figure 3. Android-Based Electrical Safety Inspection and Testing System Design

The model of electrical safety inspection and testing system started with the determination analysis model of electrical inspection and testing method manually and digitally. Then the researcher doing the activity of electrical safety inspection and testing that consist of checking administration documents, assessment, measurement, calculation, and checking, and value determination from standard electricity that refers to Indonesian National Standard (SNI), International Electrotechnical Commission (IEC), The Institute of Electrical and Electronics Engineers (IEEE) dan American National Standards Institute - International Electrical Testing Association (ANSI-NETA). Then the arrangement of software application is done by Delphi, Android Studio, MySQL, Pascal dan Java.

Next, the digital electrical safety inspection and testing is done with smartphone, followed the analysis and decision making in order to gain the conclusion the equipment is require the meet safety requirement or not. The last is printing the electrical safety inspection and testing result.

3. Results and Analysis

Several testing and analyses are applied in order to test the function of system, whether the system is running properly or not. The testing system that used is Black Box method. Black Box method is a testing process that done through observation of result through the data and app function checking. It is possible to test the program directly observe the app without knowing the program structure. The testing on app is done in order to ensure that the app running well in accordance with the expected purpose. Black box testing focused on the software function [24][25]. The android based electrical safety inspection and testing system is presented in Table 5.

Table 5. Black Box Testing Components

No	Components	Testing Method
1	Starting Menu	Black Box
2	General Data	Black box
2	Administration Document Assessment	Black Box
3	Assessment	Black Box
4	Measurement	Black Box
5	Calculation	Black Box
6	Testing	Black Box
7	Photo	Black Box
8	Recommendation	Black Box
9	Conclusion	Black Box

Here are the results of software testing that using black box method based on observation:

a. Starting Menu Component Testing

The testing menu on app is done when the programmer doing input data with inspection and testing the app. The starting menu component display is presented in Figure 4 and 5.

Figure 4. Starting Menu Display 1

Figure 5. Starting Menu Display 2

The result of Black Box testing on starting menu component is presented in Table 6.

Table 6. Black Box Testing Result on Starting Menu

Tested Component	Result	
	Expected Result	Conclusion
Starting Menu	The system displays starting menu and checking input	[<input checked="" type="checkbox"/>] Succeed [<input type="checkbox"/>] Not Succeed

b. Testing on General Data Components

General component data is the media to input the OSH inspection and testing. It consists of the owner's data, location, equipment types, electric power capacity, frequency and voltage. General component data is presented as Figure 6.

Figure 6.General Data Component Display

The result of Black Box testing on general data component is presented in Table 7.

Table 7. Result of Black Box Testing on General Data

Tested Component	Test Result	
	Expected Result	Conclusion
General Data	The system accepted all the data and divided it into the data classification.	[<input checked="" type="checkbox"/>] Succeed [<input type="checkbox"/>] Not Succeed

c. Check List Component Testing (Administration Document, Assessment, Measurement, Calculation, And Testing)

The check-list component testing that consists of administration document checking, assessment, measurement, calculation, and testing is processed in order to gain conclusion. Check-list component display is presented in Figure 7,8,9, 10 and 11.

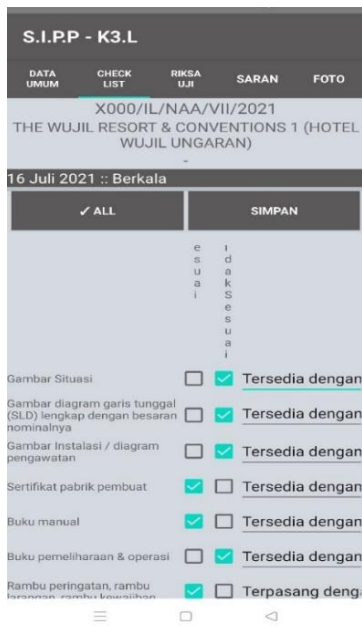


Figure 7. Administration Document Check-List Display



Figure 8. Assessment Check-List Display



Figure 9. Measurement Check-List Display

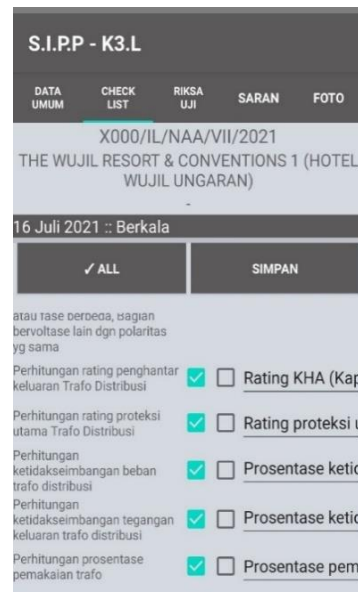


Figure 10 Measurement Check-List Display



Figure 11. Testing Check-List Display

The black box testing on check-list component is presented in Table 8

Tabel 8. The Result of Black Box Testing on Check-List Component

Tested Components	Result	
	Expected Result	Conclusion
Check-List (Administration Documents, Assessment, Measurement, Calculation and Testing)	The system inputs administration document, assessment, measurement, calculation, measurement and testing.	[√] Succeed [] Not Succeed

d. Photo Component Testing

Photo documentation page is the page that used to input media and photos testing and checking as a media to convince that the electrical safety inspection and testing is met the qualification. Photo component display is presented in Figure 12.

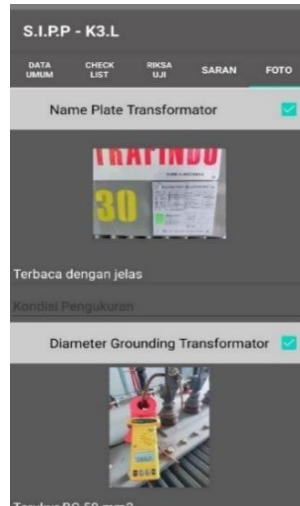


Figure 12. Photo Component Display

The black box result of photo component is presented in Table 9.

Table 9. Result ff Black Box Testing on Image Component

Tested Component	Result	
	Expected Result	Conclusion
Photo Component	The system accepts all the input data and automatically divided into the classification.	[√] Succeed [] Not Succeed

e. Recommendation Component Testing

Recommendation component page is a page that used to input recommendation from testing and checking that done, and expected to be a recommendation for repair and maintenance in order to meet safety requirements. Recommendation component display is presented in Figure 13.



Figure 13. Recommendation Display

The result of black box testing on recommendation component is presented on Table 10.

Table 10. Result Black Box Testing on Recommendation Component

Tested Component	Result	
	Expected Result	Conclusion
Recommendation Component	The system accepts all the input data and automatically divided into the classification.	[<input checked="" type="checkbox"/>] Succeed [<input type="checkbox"/>] Not Succeed

f. Testing on Conclusion Component

The conclusion component displays the testing conclusion, then from the testing conclusion, the tester proceeds it in order to meet the conclusion in the end of electrical safety inspection and testing.

The result of Black Box testing's conclusion is presented in Table 11.

Table 11. The Result of Black Box Testing on Conclusion Component

Tested Component	Result	
	Expected Result	Conclusion
Conclusion	The output of android system qualified meet safety requirements.	[<input checked="" type="checkbox"/>] Succeed [<input type="checkbox"/>] Not Succeed

System Analysis

The analytical system is done from process of interview and inspector's commentary of electrical safety in the field after app testing. System comparison is presented in Table 12.

Table 12.The Pros and Cons Comparison Analysis

No	Aspect	Manual Testing System	Digital Testing System
1.	Connection	Without connection	Using internet connection (online and offline)
2.	Inspection and Testing form writing	Manually with different formats	The inspection is done digitally and using digital form according to standard
3.	Inspection and testing report making	Manually, if something wrong happened then the inspector must fix the problem with taking picture and input in to report in computer, takes longer process.	Done digitally, if a problem appears the inspector can directly upload it to the app and easily fix the problem.
4.	Report process	Taking longer time because the inspector must transfer the data to computer.	The process of report faster, directly submitted and the reviewer can also check the report faster.

4. Conclusion

An android based on electrical safety inspection and testing system is already made and developed based on functional testing and the app is running well. The result shows that the app is recommended to inspect and test the electrical safety with quick and accurate result.

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