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Conference Paper · November 2019

DOI: 10.1109/ICoSNIKOM48755.2019.9111585

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Prototype of Radio Frequency Identification Technology Utilization for Monitoring of BTS Room Using of IoT (Internet of Things) System

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Abstract— **The level of battery theft in the BTS room often occurs. RFID prototype is used to open the BTS room is replacing the conventional key. To improve the BTS room security system, a vibrating sensor is used which is applied to the BTS room door, if anyone wants to break or damage the BTS room door by force then the alarm sounds, and use an ultrasonic sensor to detect whether there is a person or object in front of the BTS room, if a person or object is blocking in front of the BTS shelter ≤ 100 cm, the alarm will sound continuously. Also, the BTS shelter can be monitored via a smartphone as well as getting notifications both in email, smartphone and in the Blynk application.**

*Keywords—**RC-522 RFID Sensor, Ultrasonic HC SR04, Vibrate SW-420, BTS room, and Blynk.***

I. INTRODUCTION

Monitoring the safety of the BTS shelter so far is still done manually so it takes a lot of energy and time. Not a few also many thefts of electronic devices in the BTS shelter because of the condition of the BTS that has no guards who can 24-hour monitor the BTS shelter. At this time the BTS shelter is still using a manual locking system by using a conventional key. The use of conventional keys is not practical today, because technicians must carry many keys when checking or accessing base conditions. The use of conventional keys is also easily opened by thieves because thieves develop ways to open the door of the house [1], [2]. Increasing the development of microcontroller technology at present, the security system can be done by using electronic devices as a substitute for conventional key security systems [3].

By utilizing the advantages of Radio Frequency Identification (RFID) technology that can penetrate the material, it can be utilized to create a system that can sound an alarm when a theft occurs with a hidden device [4]. The data communication technology between an RFID reader and an electronic tag (RFID tag) on this system is contactless, real-time and wireless [5]. Data identification on RFID tags is done through radio frequencies that propagate through the air media at a certain range according to the features possessed by each RFID module (consisting of RFID reader and RFID tag) used. In general, unique RFID tag data is stored or embedded in a chip card so that the influence of natural conditions such as dust, dirt or air temperature will not reduce the quality of data communication that occurs. So, that the RFID sensor is suitable to be used as an input sensor in opening the BTS shelter. Research conducted for designing RFID-based home security access systems and atmega328p microcontrollers [6], [7]. This research was conducted because of the rise of thieves from the origin of the house so as to provide an RFID-based door security solution. With this system, someone who wants to enter the house through the main door must have a registered card in order to open the door of his house, and also if the card is not registered with the RFID Tag, the alarm/buzzer will light up indicating that there is unknown access. try to enter the house. The limitation of this tool is that there is no homeowner notification if there is someone who wants to try to enter by attaching an RFID card that is not registered in the program. The BTS shelter safety device she made is having some weaknesses including the password [8] used is general so that if anyone who sees it can access it, BTS shelter communication with a smartphone can only be 10 meters because it uses a Bluetooth module HC-05 and to increase security must be added to the smartphone report.

This system is also equipped with an HC-SR04 ultrasonic sensor which functions to find out if someone is in front of the BTS shelter with a distance of ≤ 100 cm, the alarm will sound, and also equipped with a SW-420 vibrating sensor which is mounted on the BTS shelter door if there is someone who wants to steal or forcibly dismantle the BTS shelter door then the alarm will sound because there is a vibration at that time [9]–[11].

This alarm system someone who has evil intentions and does not have access to the BTS shelter so that it can be known by residents and this is also a better preventive measure to avoid further loss. This system is expected to be one alternative solution that can be used to overcome someone who has unknown access to the BTS area and in front of the BTS Shelter. The testing of this system was carried out in an open area using a prototype BTS Shelter that resembled it. The farthest range from the RFID Reader reading distance with the RFID Card is up to 4 cm.

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II. METHOD AND EXPERIMENT

A. *Designing Tools and Systems*

At this stage, the overall tool design is carried out which forms a prototype of the BTS shelter safety system that is to be realized. The stages of planning tools and systems can be represented by the tool design flow chart in Fig. 1 below:
The research method that will be used to solve the problems consists of several stages, namely:

1. Literature Study

At this stage, there will be a deepening of both the concepts and the latest theories of BTS characteristics, BTS Shelter, Microcontroller, RFID RC-522, HC SR04 Ultrasonic Sensor and Vibrate SW-420 Sensor. Sourced from international and national journals, theses and supporting theory books. So, that later can analyze the literature obtained.

2. Tool Design

At this stage, the design of a prototype BTS shelter will be carried out with a size that resembles the Huawei 3900 BTS shelter, which is 50 cm long, 35 cm wide and 80 cm high using a 1.2 mm 1 sheet iron plate. Then the tool components are placed in a black box and use 2 solenoid door locks.

3. Tool Test

At this stage the tool testing system is carried out by observing the method by observing the object to be examined in relation to the problem to be discussed, namely by conducting an experiment on the device that has been made, to see and observe the performance of the tool.

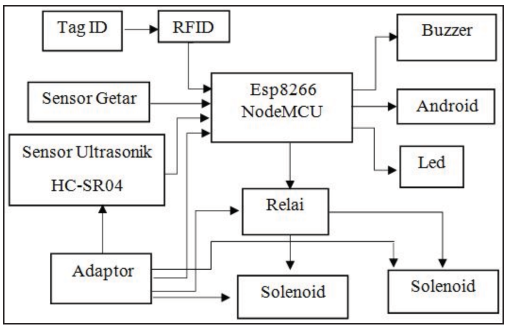

Fig. 1. Diagram Block Design System

B. *Toolkit Schematic*

The following is a schematic prototype of the BTS shelter safety system using fritzing software:

1. Using the Esp8266 NodeMCU microcontroller as the main controller which can be combined with a ready-made module and can also be integrated with the Blynk application without the need for a wifi module.
2. Uses Radio frequency identification (RFID RC-522) as the main input used to read ID tags.
3. The HC-SR04 Ultrasonic Sensor is used to monitor and activate the buzzer when the distance is meter 1 meter.
4. SW-420 Vibration Sensor is used at the BTS shelter door to detect whether there is vibration or not at the door.
5. Mifare 2k/ ID Tag/E-KTP is used to open the BTS shelter door if it is registered.
6. 5VDC 2 Channel relay which is used as an automatic switch to turn on or turn off the load.
7. Buzzer as a warning in the form of sound.
8. Push Button is used to make the BTS shelter on a smartphone.
9. The 12V 1A adapter is used as a tool voltage source.
10. Two door lock solenoids are used as locks on the BTS shelter door.
11. The cable is used to connect from one component to another component.

C. *Components Used*

Table 1 Components

No	Components	Total
1	Pcb	1 ea
2	RFID RC522 sensor	1 ea
3	Ultrasonik HC SR04 sensor	1 ea
4	Getar SW-420 Sensor	1 ea
5	Esp8266 NodeMCU	1 ea
6	Buzzer	1 ea
7	Red Led	1 ea
8	Green Led	1 ea
9	Jumper Cable	23 ea
10	Relay 5v 2 channel	1 ea
11	DC Jack	2 ea
12	Pin Header	1 ea

Table I above, the components used in the manufacture of tools in this research. There are 12 types of components used, namely 3 sensors as input, 1 Esp8266 Node MCU as a processor, 1 green led, red led, relay, and buzzer as output and other components such as PCB, pin header, jumper cable, dc jack namely supporting material in making this tool.

D. *Tools and Materials Used*

Table II. Tools and Material

No	Tools/ Material	Total
1	Iron Plat 1,2mm	1 ea
2	Drill Machine	1 ea
3	Gerinda Machine	1 ea
4	Black Box	1 ea
5	Solder	1 ea
6	Tin	1 ea
7	Black Tape	1 ea
8	Adaptor 12Vdc	1 ea
9	Adaptor 5Vdc	1 es
10	Baut	14 ea

Table II above, the tools and materials used are good in making prototype BTS shelter and in making the tool itself which requires 12 types of tools/materials used as in the table above.

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E. Prototype Design

Fig. 2. RFID design in BTS Shelter

In Fig. 2 above is the design of the BTS shelter tool specifications of length 50 cm, height 80cm, and width 35 cm. While sensors are applied to the front door of the BTS shelter with the ultrasonic sensor appearing out, the vibrating sensor mounted on the BTS shelter door then the RFID sensor is applied under the ultrasonic sensor and located in the middle between the red and green LEDs with the buzzer. So, the size of the buzzer sensor and led itself is applied to the front door of the BTS shelter with a length of 10cm and a height of 15 cm.

III. RESULT AND DISCUSSIONS

A. RFID-RC522 Sensor Analysis

In the results of experiments conducted in table III to testing the RFID sensor voltage and in table IV testing the RFID sensor current, the relationship between the voltage and the RFID sensor is obtained in the table below;

Table III. Testing Result of RFID Sensor Voltage

Test / CM	Vin (V)	Vin Load (V)				
		1cm	2cm	3cm	4cm	5cm
I	3,175	3,162	3,176	3,177	3,225	-
II	3,175	3,168	3,179	3,177	3,225	-
III	3,175	3,169	3,178	3,179	3,227	-
IV	3,175	3,163	3,178	3,180	3,225	-
V	3,175	3,172	3,178	3,180	3,226	-
MEAN	3,175	3,1668	3,1778	3,1786	3,2256	-

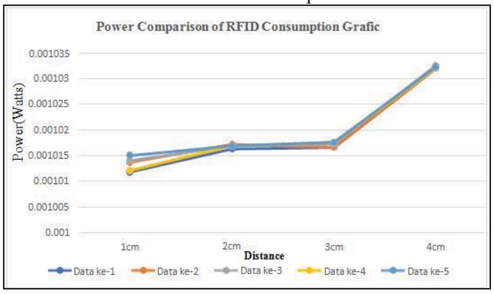
In Table IV presented, we can know the relationship between voltage and current carried out within a distance of 1cm to 4 cm, the farther the RFID card with the RFID reader, the greater the voltage needed because this RFID sensor requires more voltage to be able to reach or RFID card reading with a longer reading distance.

Table IV. Testing Result RFID Sensor Current

Test / CM	Iin (mA)	Iin Load (mA)				
		1cm	2cm	3cm	4cm	5cm
I	0,32	0,32	0,32	0,32	0,32	-
II	0,32	0,32	0,32	0,32	0,32	-
III	0,32	0,32	0,32	0,32	0,32	-
IV	0,32	0,32	0,32	0,32	0,32	-
V	0,32	0,32	0,32	0,32	0,32	-
MEAN	0.32	0,32	0,32	0,32	0,32	-

Because the RC-522 RFID sensor is a passive tag, this sensor can only read RFID cards as far as 4 cm, while the current required by this RFID sensor is constant or of a fixed value in card reading both near and far distances.

Table V. The Power Comparison of RFID



In Table V above is a comparison chart of the power consumed by the RFID sensor conducted during 5 trials in 4 different distances from 1cm to 4cm, with the following formula:

$$P = V \times I$$

Then the results obtained as shown in the curve above shows that the farther the RFID card with the RFID reader, the greater the power required because the RC-522 RFID sensor uses passive tags so that it requires a large power because the coil on the antenna on this passive tag will form a field magnet, the magnetic field will induce an electric voltage which gives power to the passive tag so that the RFID reader must emit radio waves that are large enough and therefore require a large amount of power. This type of RFID is also only able to read or reach in close range, which is 4cm far to read the RFID card because it uses passive tags.

In table IV and V are testing results of the RFID device system using 3 different RFID cards 2 of which have already been registered and 1 of which has not yet been registered. The results obtained as in the table and the system run smoothly 100 % as desired in this study, and no error occurred. But notifications on e-mail, smartphones, and blynk applications depend on the network connection, if the internet network used is stable it will quickly enter the notification.

B. Analysis of Ultrasonic Sensors HC-SR04

Table VI. Distance of Electronic Sensor Testing

Actual Distance (cm)	Measured of Distance(cm)			Time Achieved of Sensor (ms)			MEAN		%
	X1	X2	X3	T1	T2	T3	Xr	Tr	Accuration
10	10	10	10	0.58	0.58	0.58	10	0.58	100
20	20	20	20	1.16	1.16	1.16	20	1.16	100
30	30	30	30	1.74	1.74	1.74	30	1.74	100
40	40	40	40	2.32	2.32	2.32	40	2.32	100
50	50	50	50	2.90	2.90	2.90	50	2.90	100
60	60	60	60	3.48	3.48	3.48	60	3.48	100
70	70	70	70	4.06	4.06	4.06	70	4.06	100
80	80	80	80	4.65	4.65	4.65	80	4.65	100
90	90	90	90	5.23	5.23	5.23	90	5.23	100
100	100	100	100	5.81	5.81	5.81	100	5.81	100

In table VI talking about ultrasonic sensor distance testing with a sensor reading range from 10 cm to 100 cm, the relationship between the measured sensor distance and

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the actual distance is obtained as shown in the comparison curve below:

Table VII. Graph of Sensor Distance and Actual

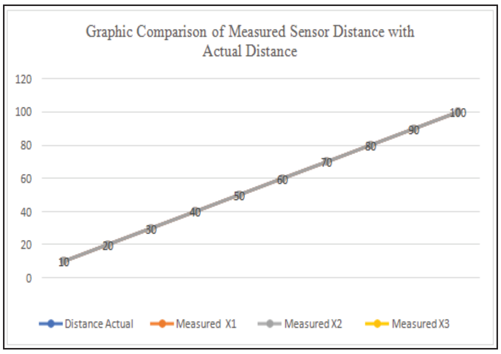


Table VI above it is known that the comparison between measuring the distance of the sensor against the object with the measurement of the object using the ruler results in 100 % the same value from a distance of 10 cm to 100 cm. then it can be concluded that the reading of the ultrasonic sensor with the ruler between 10 cm to 100 cm the result is 100 and exactly there is no difference in value and erosion of values that occur.

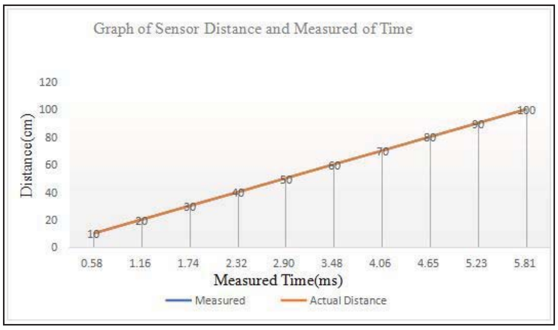
Sensor travel time values are calculated manually from the following formula:

Then obtained the sensor travel time values with a range of 10 cm to 100 cm as shown in the graphic below:

$$t = \frac{S \times 2}{v} \qquad (1)$$

Then obtained the sensor travel time values with a range of 10 cm to 100 cm as shown in the graphic below:

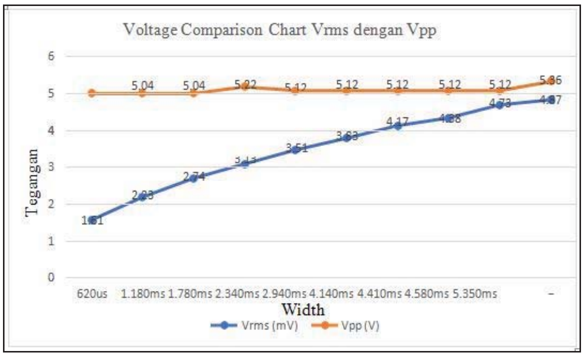
Table VIII. Graph of Sensor Distance and Measured of Time



In Table VIII above, the relationship between the measurement of distance reading with the required time of the sensor, in the picture the time needed for the sensor to detect obstacles at a distance of 10 cm is 0.58 ms and each multiple 10 cm farther then the travel time also increases 0, 58 ms and a constant of it uterus every 10 cm multiple. This indicates that there was no error in the calculation because of the farther the distance the time needed for the sensor to detect the object the distance was longer because the reflection is getting bigger or farther.

In table 4-6 the wavelength test shows the results of a comparison between Vrms and Vpp voltage and its relationship to the pulse width, as shown in the graphic below:

Table IX. Voltage Comparison Chart



In Table 9 the comparison of graph Vrms with Vpp and its relationship to the pulse width. So, from the graphic image presented above is the farther sensor distance to the object in front of it, the wavelength or pulse width will be greater, this is by the characteristics and there is no error in the measurement range of 10 cm to 100 cm. While the Vrms value is the same as the ultrasonic sensor trigger pin voltage value, the value obtained as shown above is that the farther the object is towards the sensor, the greater the Vrms needed, but at Vpp the peak to peak voltage needed is the farther the sensor detects the object, the greater because diosiloscope display even higher pulse shape, and pulse waves are the same in the form of contact.

This is the same as the characteristics of the ultrasonic sensor, both the voltage required to detect objects farther away, the greater because the ultrasonic waves emit farther and higher, so the Vrms and Vpp values are farther away.

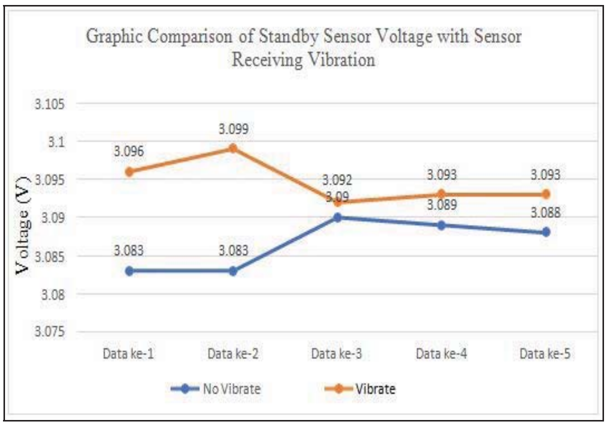
C. Analysis of The Vibrating Sensors SW-420

In table 10 in the vibration sensor voltage test in Chapter IV which was carried out for 5 experiments in 2 different conditions, namely when high logic or receiving vibration and also when low noise when not receiving vibration then the results of the comparison are obtained as shown below:

Table X. Vibration Sensor Voltage Test

Condition	TESTING (V)					
	I	II	III	IV	V	MEAN
Not Vibrate	3,083	3,083	3,090	3,089	3,088	3,704
Vibrate	3,096	3,099	3,092	3,093	3,093	3,094

Table XI. Graph Comparison of Sensor



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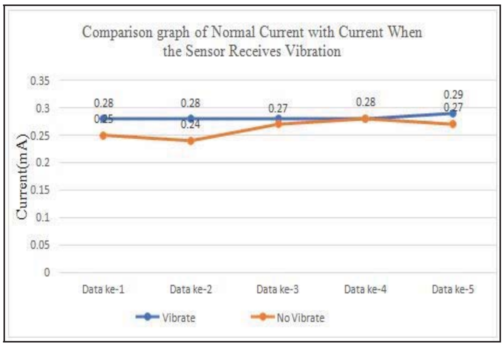
In table 11 graph comparison of Sensor above where the ratio between the sensor voltages vibrates when conditions are low to when conditions are high. In the above experiment where the sensor is supplied with a 3V voltage, when the sensor receives vibration or has high logic, the voltage value on the sensor's digital output is greater than when the sensor has a low logic or does not receive vibration, because the coil on the sensor and surrounded by a magnetic field will move towards the magnetic field or vice versa it will cause an induced voltage on the conductor itself so that it will produce electrical voltage at the end of the coil wire that causes this sensor to rise in voltage when getting vibrations.

In table 12 above the comparison of the current of the sensor vibrates when it receives vibration and when it does not receive vibration. It is increases the current value even though it is small or not large than when the sensor does not receive vibration. But on the characteristics of the working principle of the vibrating sensor itself when there is a mechanical vibration that creates a force it will hit the piezoelectric material so that the piezoelectric material will produce an electric charge, but the electric current generated by the piezoelectric itself is very small.

Table XII. Comparison of Current



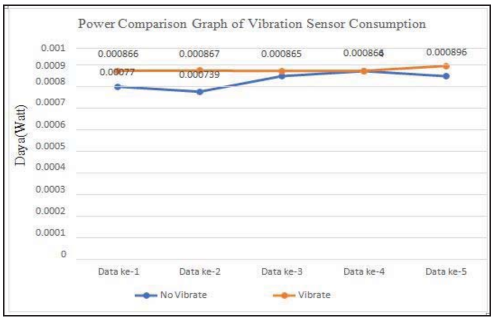
From the experimental data and the characteristics of the vibrating sensor itself, it can be concluded that this sensor is running 100% normal and there is no percentage of the eruption that appears.

So, after getting the value of Current and Voltage can calculate the power formula with the formula below:

$$P = P \times I \quad (2)$$

So, we get the value of power consumption required by the sensor as shown in the curve below:

Table XIII. Vibration Consumption

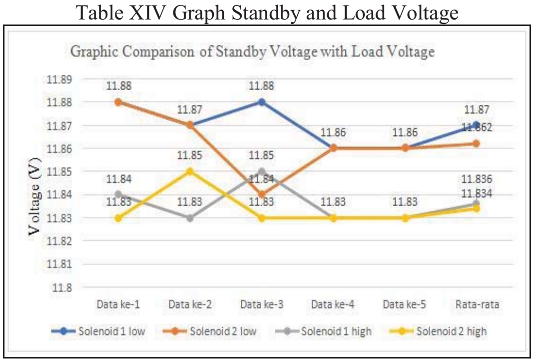


From the table XIII above is the result of comparison of power consumed in two conditions, namely when the sensor does not receive vibration and when the sensor receives vibration, the results of the power value are as shown in the curve above. The power needed for the sensor when it receives vibrations will be greater than the sensor that does not receive vibrations because in the previous discussion the same voltage and current sensors will be greater when receiving voltage because it produces voltage and current even though the value is very small.

D. *Load Analysis*

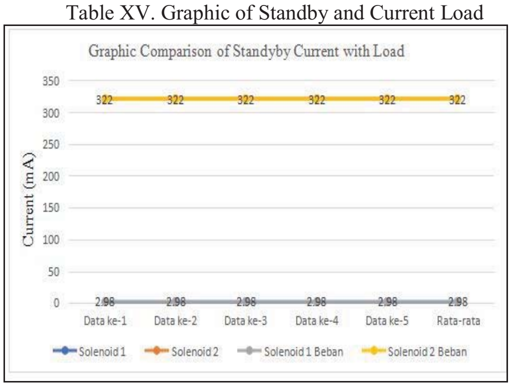
In table XIV in testing the voltage of 2 solenoids that have been done, then get the results of the voltage comparison in the picture below:

Table XIV Graph Standby and Load Voltage



In table XIV above is the result of voltage comparison data values between 2 solenoids in standby or low logic with active or high logic. When the solenoid has high logic, both the solenoid 1 and solenoid 2, the voltage will be smaller than the solenoid when the logic is low, because the coil in the solenoid will get a current supply so that it turns into a magnetic field and pulls the tongue of the solenoid into high logic. Therefore, the voltage of the solenoid has decreased the voltage value of about 0.03v so that excessive heat does not occur in the coil when a sudden large, current increases, the voltage value decreases.

Table XV. Graphic of Standby and Current Load



In the graph above 15 is a comparison of the value of the solenoid current when the condition is off and also when the condition is on. These currents can rise very significantly when logic high or active because it is the value of specifications and characteristics of the currents needed by the solenoid, this happens because the solenoid requires a greater current so that the winding in the solenoid will become a magnetic field and attract the tongue solenoid so

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that it has high or active logic. After the condition is off or there is no more current in the solenoid, it will return to normal and the coil will not pull the tongue of the solenoid inside the solenoid body. However, there is a difference in the value of the workflow, the specifications of the solenoid itself workflow is worth 600mA while at the time of testing these 2 solenoids only get a value of 323 mA and are constant for 5 experiments. The difference in value is quite far nearly 2 times the value of the current obtained in this study, there may be noise in these specifications because in this study alone to move 2 solenoids when logic high only using Adapttop 12V 1A is capable. Then it can be concluded that there is noise when measuring the specifications of the solenoid.

E. Alarm Analysis

From the experimental data in table 15 testing the alarm system using 3 sensors, namely ultrasonic sensor, and vibration sensor, the results obtained run 100% by what is desired in the workings of this system.

Table XVI. Final Comparison

Condition	FINAL					
	Led Hijau	Led Merah	*Buzzer*	Solenoid	Notif *smartphone*	Notif Email
-	off	off	off	Low	off	off
No Vibrate	off	off	off	Low	off	off
Vibrate	off	Aktif	Aktif	Low	Aktif	Aktif
Distance 0 - 100cm	off	Aktif	Aktif	Low	Aktif	Aktif
Distance ≥ 100cm	off	off	off	Low	off	off

When the ultrasonic sensor detects an object in front of it with the distance of the object to the BTS shelter door ≤ 100cm, the alarm will continue to sound or be active until the distance of the object in front of the BTS shelter is ≥ 100cm, then the new alarm will be inactive or no longer sound. On the vibrating sensor that has been applied to the BTS shelter door if the BTS shelter does not receive vibrations or no one wants to open or bang on the door then the alarm will be inactive, but if the door of the BTS shelter receives vibrations from outside then the alarm will be active how long the vibration will occur at the BTS shelter door and will automatically deactivate when there is no more vibration at the BTS shelter door. The alarm system is running 100% as desired in this study.

IV. CONCLUSIONS

Based on the result, the maximum reading distance of the RFID RC-522 Reader against the RFID Tag without obstructions during implementation is 4 cm when the RFID tag is brought close to the RFID Reader. The closer the RFID Tag is to the RFID Reader the greater the power needed, because this type of RFID is a passive tag so the RFID Reader must emit a radio wave that is large enough. Ultrasonic sensors are able to read objects and do not occur with an actual distance between 10 cm to 100 cm. The designed alarm system has a 100% success rate from a number of tests that have been carried out. And the notification on an integrated smartphone and e-mail depends on the quality of the network connection on the device and smartphone.

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