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Building of Monitored Anti-Bacterial Smart Sterilization Room Based on Internet of Things Using PIR Sensor and Its Quality Assurances

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ABSTRACT The dangers of bacteria can cause health problems or infections of the respiratory tract. This main research objective is to build monitored sterilization room which can serve practicable scenarios and has assurences regarding its function. The research proposes smart room sterilization system based on the Internet of Things (IoT) using a Passive Infrared Receiver (PIR) which has role as detection system. The advantage of this system is managed and monitored safety sterilization process remotely by Blynk. The system has been tested by taking 7 data from 1 object with 3 scenarios; sterilization without an object, sterilization by detecting objects, and sterilization by detecting objects which is back to the room. This tool has also gone through measurement quality assurance testing by adopting ISO 17025 with acceptable result including sensitivity, selectivity, precision, working range, tool toughness, and measurement uncertainty. Moreover, quality of service (QoS) test in this system also has been conducted by getting an average delay of 122 milliseconds, throughput of 1045 byte/s and packet loss of 0.06%. Based on the result, this sterilizer system can be monitored, operated remotely, equipped with a security system, and has quality assurences to be implemented for providing healthier room.

INDEX TERMS Smart Room, UV, Sterilization, IoT, PIR , QoS

I. INTRODUCTION

Sterilization is an important process to kill bacteria, this is because it can suppress the growth of bacteria in the room. The dangers of bacteria can cause health problems or infections of the respiratory tract such as flu, bacteria TB (Mycobacterium tuberculosis)[1]. The healthy environment is needed to keep the room sterile from bacteria.

Conventional room sterilization usually uses the spray method, thermal method, chemical method, and gas method. However, this method has problems such as requires more time, human resources, and chemicals left on objects. Another sterilization method is using radiation by ultraviolet (UV) C rays. The ultraviolet light has a wavelength of < 280 nm which can damage to bacterial DNA. The UV C can kill bacteria that stick and float in the air by direct irradiation [2].

UV C sterilization is very dangerous for humans because it can cause skin cancer and blindness. Therefore, for a security system, a PIR sensor is needed in this safety system. The PIR sensor is used to detect objects in the room. When this system detects the object entering the room, the sterilization process will stop. This sterilization is running when the room is empty or there are no objects. Based on the research the use of ultraviolet lamps in biological safety takes 15 minutes for this system to be controlled so that it does not turn on nonstop.

For the automation process, the Internet of Things (IoT) is used because it can be controlled and monitored through the Blynk platform. Internet of Things has been implemented in smart classes[3], smart rooms [4], and even to develop smart cities[5] that are more complex and wider. Blynk platform is used as a medium to monitor and operates the air bacterial sterilization system using UV C which is believed able to damage and kill cells. For monitoring system, the data system is sent using Wi-Fi into the internet of things (IoT) platform so that it can be monitored whether the sterilization time is going well.

Recently, It has been reported that internet of thing using control system completed by Blynk has been applied to build smart sterilization room [6][4][6]. Previous system that has already established is building low cost UV-C disinfectant sterilization box [8]. Another approach was created by using mobile unit with solar panel to charge the batteries [9]. Autonomous robot also has been developed to increase the efficiency[10]. The improvement of this research comparing to the others sterilization system is that the assessment of the quality system. The quality assurance is crucial in medical or health equipment particularly that is related to safety protocol.

This research proposed ISO 17025 and QoS to guarantee that the system is robust to run the procedure. ISO 17025 is the standard of laboratory measurement system that can assess such as calibration, sensitivity, selectivity, precision, working range, tool toughness, and measurement uncertainty[11]. The QoS is been aplllied to see the quality of service regaridng the networking. It is neceesary to see how proper this tools regarding actual observing by internet[12]. Hopefully this system could be as referense regarding sterilization system especially for chamber or room and gains awereness about quality assurence in medical device or system application. Therefore the objective of this study is to build monitored sterilization room which can serve practicable scenarios and has assurences regarding its function

II. MATERIAL AND METHOD

The method that proposed in this research is to build the smart sterilization room system is by designing an internet of things-based intelligent anti-bacterial room sterilization system using a PIR sensor and conducted testing experiments to investigate the quality of system.

A. HARDWARE

In this project, a laptop is used as a tool in managing all materials and data that will be used. In addition, the laptop is also used as a coding medium for all components and for data retrieval media, the specifications of the laptop used are Intel(R) Celeron(R) processor speed 1.50 GHz, memory used is 400 Gb and RAM is used 8 GB, smartphone is used to operate and monitor the sterilization system.

Passive Infrared (D-SUN-India) is the component which has role as sensor to detect the object. If object is detected, the sterilization irradiation will stop. NoduMCU (WC-China) is an electronic board based on the ESP8266 chip with the ability to run microcontroller functions and an internet connection.

In this project, a Liquid Crystal Display (Oric Display-China) is used to see the length of time for sterilization and the presence of objects that can be monitored through an LCD monitor. I2C (SZYTF-China) is used to save pins on the NodeMCU and simplify connections to minimize errors and make it easier to troubleshoot when problems occur on the LCD display.

The sterilizer used is a UV C lamp because it can damage bacterial cells. The relay functions as a switch to turn the UV lamp on and off. The use of the adapter (Lincoiah-China) in this study serves as a NodeMCU microcontroller resource to run all the components used. Buzzer (hydz-China) is used as a notification or notification when an object is detected during sterilization.

B. SOFTWARE

Arduino IDE serves to program the NodeMCU microcontroller. This software is used for reading PIR sensor script. The sensor is an object detection sensor. Script the program to run commands on the device used. Blynk functions as a cloud that stores all data from sensor readings and displays data in the form of values or graphs. Platforms This can be accessed using a PC and smartphone because it is in the form of a website and applications on smartphones so it's more practical. To combine between platforms Blynk with NodeMCU using the access key and device ID on the Blynk account combined with the Arduino IDE script program.

Wireshark software is used as a network protocol analyzer to analyze network traffic during data transmission. This software has a function that is used to get quality QoS results when running the process of sending data to websites or applications on Android via the internet network.

C. RESEARCH FLOW

The development of an anti-bacterial smart room sterilization system (Smart Sterilization Room) based on the Internet of Things (IoT) using a PIR sensor (Passive Infrared Receiver) can be seen in the diagram flow (FIGURE 1).

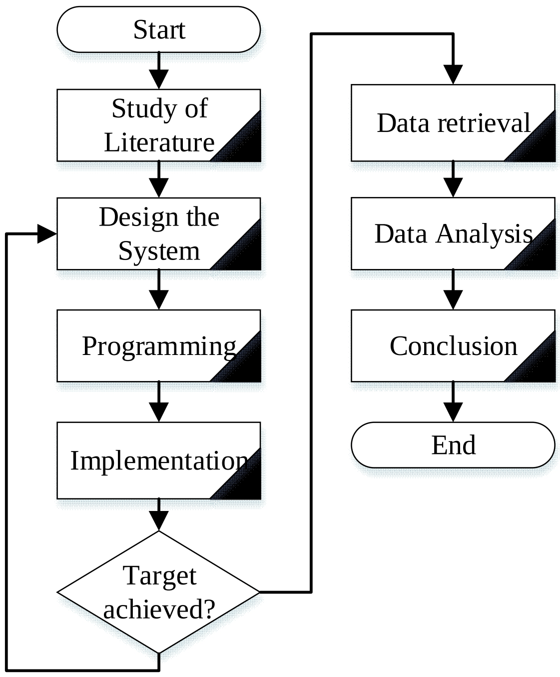

FIGURE 1. Research Flow

The first step is finding information as a reference to find problems and find research concepts. This is necessary to see state of the art and the research gap. The second stage is system design or tool making. In this stage all components are assembled to build a bacterial sterilizer use NodeMCU. The third stage is programming stage. The program script will be compiled as a command to run the microcontroller using the Arduino IDE software. The fourth stage is the implementation of the program where the script that has been compiled is applied in NodeMCU to find out whether the script that has been compiled is successful or not. If the script that has been designed is successful, it can be continued to the next stage and if it fails the researcher will repair the program script. The fifth stage is taking data in an empty room by placing the device, the data taken is the functioning of the PIR sensor and the length of time for sterilization whose output is stored on the Blynk platform. The sixth stage is analyzing the data that has been obtained. After this process, sending data will be analyzed. Based on this analysis data, it can be seen how many times the PIR sensor detects objects during the sterilization period and the length of time during sterilization. The seventh stage is drawing conclusions where the data that has been obtained and concluded.

D. SYSTEM PLANNING

In FIGURE 2, a block diagram of the system where the PIR sensor roles as input, the NodeMCU ESP8266 roles ad processing stage, and the Blynk is the output system. In this study, the PIR sensor will send data to the NodeMCU whether the sensor detects an object or not. After that the NodeMCU sends the sensor data to the blynk platform. Data from NodeMCU sent to platform blynk uses Wi-Fi which will analyze the value of the Quality of Service (QoS) parameter.

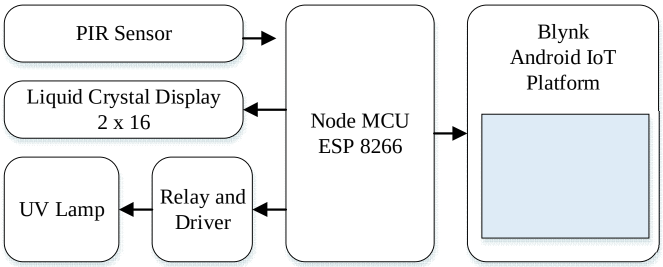

FIGURE 2. System Block Diagram

E. CALCULATION OF STERILIZATION TIME

DNA is the main target for ultraviolet radiation. This ultraviolet affects the bacterial cell biomolecular from the pyrimidine base[12]. More than 3 decades, the studies have shown that the effect of ultraviolet radiation is to block DNA and RNA polymerases that inhibit the replication of DNA strains and their transcription[13]. Ultraviolet light has been used in laboratory studies as an effective germicide and virucide[14]. The levels of ultraviolet light vary for organisms and are efficiently used for the sterilization of organisms and viruses. At the minimum radiation in the BSC (Bio Safety Cabinet) which is 40 W/cm2, it takes 12.5 until 15 minutes to reach 30,000 j/cm2 the germicidal effect of spores of organisms by 1 ultraviolet manufacture[15].

F. QOS PARAMETER (QUALITY OF SERVICE)

QoS is defined as a mechanism or method that allows services to operate according to their respective characteristics in an IP (Internet Protocol) network[16]. QoS refers to the ability of a network to provide better services for certain network traffic through different technologies[17]. QoS offers the ability to define the attributes of the network services provided, both qualitatively and quantitatively. TABLE 1 shows the percentage value of QoS.

TABLE 1
QOS parameter index [18]

Value	Percentage (%)	Index
3,8 – 4	100 %	Very Satisfactory
3 – 3,79	75 – 94,75 %	Satisfying
2 – 2,99	50 – 74,75 %	Less Satisfactory
1 – 1,99	25 – 49,75 %	Bad

1. THROUGHPUT

Throughput is the effective data transfer rate, which is measured in bps (bits per second). Throughput is the total number of successful packet arrivals observed at the destination during a given time interval divided by the duration of that time interval[19]. Throughput categories are shown in TABLE 2. The following is the calculation used to determine the Throughput value, namely[20]:

$$Thr\quad hp = \frac{A\quad o\ d\quad s\quad t}{D\quad d\quad ti} \quad (1)$$

TABLE 2
Throughput category index[18]

Category	Packet Loss %	Index
Very Good	0	4
Good	3	3
Average	15	2
Bad	25	1

2. PACKET LOSS

Packet Loss is a parameter that describes a condition that shows the total number of lost packets that can occur due to collision and congestion on the network[21]. The packet loss index and categories are shown in TABLE 3. The calculation formula to get the results of the presentation of packet loss values, namely:

$$P\quad L = \frac{P\quad s\quad -p\quad r}{d\quad p\quad s} x\ 100\% \quad (2)$$

TABLE 3
Index of Packet Loss Category[18].

Category	Packet Loss %	Index
Very Good	0	4
Good	3	3
Average	15	2
Bad	25	1

3. DELAY

Delay (Latency) is the time it takes data to travel the distance from origin to destination. Delay can be affected by distance, physical media, congestion or also long processing times[22]. TABLE 4 shows the categories of delay and the amount of delay. The formula for calculating the delay is:

$$De = \frac{Ti\quad P\quad R\quad -Ti\quad P\quad S}{N\quad o\ P\quad R} \quad (3)$$

TABLE 4
Delay Category Index[18].

Latency Category	Delay	Index
Very Good	<150 ms	4
Good	150 s/d 300 ms	3
Average	300 s/d 450 ms	2
Bad	>450 ms	1

G. MEASUREMENT QUALITY ASSURANCE ISO 17025

Quality assurance of measurements in this study are very important and crucial for conducting the test. Measurement activities require validation so that the tools used to measure provide reliable results. Measurements that have guaranteed the quality of these measurements can also determine the stability of the performance of the tool minimizing medical devices error

[23]. If the quality assurance is granted the tools are more secure and suitable to be used in measuring object. It is because they have assessed by certain and particular the quality assurance test.

Quality assurance measurements by adapting or referencing ISO 17025 are as follows[11]: Sensitivity; Response tool to detect objects. For example, during sterilization, this instrument can detect objects several times in one sterilization period. Selectivity; This tool can detect different objects. This scenario is using Adults and Cats. The experiment is needed to carry out to determine whether the sensor could detect objects with different sizes. Precision; This measurement is carried out by taking 7 data from 1 object with 3 conditions to determine whether the sensor can detect the object accurately. Working Range; The extent to which the sensor can detect objects. Tool Toughness; This tool works well, the sterilization runs for a predetermined time and the PIR sensor can detect objects at the time of sterilization. Uncertainty; This tool can detect objects (Adults) with three different people.

III. RESULTS

A. BACTERIAL STERILIZER SYSTEM DESIGN

The design of the sterilizer system has been built by using NodeMCU as a microcontroller, ESP8266 as a wifi module, 16X2 LCD as information display on the device, I2C is used to save the number of pins from 16 to 4, Adapter is used as a NodeMCU microcontroller resource, Relay is used as a UV C lamp switch, and UV lamp C is used to kill or damage bacterial cells.

In this research, several designs were carried out including the results of device design, and graphics on the platform blink. The two design results are interconnected, starting from the reading of the sensor device which produces the output of the sterilization time and the detection of the PIR sensor which is then sent to the platform Blynk.

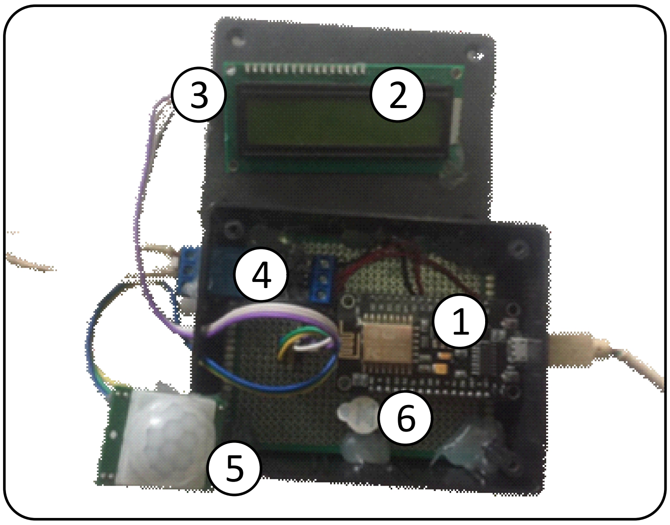

FIGURE 4. Tool Circuit Results

In FIGURE 4, there are several devices that are used and have the following functions; notation number 1 is a NodeMCU which is a microcontroller and functions to control and process data from the sensors used. Notation number 2 is a 16x2 LCD which is a type of display media or display. Notation number 3 is I2C used to reduce the number of pins from LCD to NodeM C U. Notation number 4 is a 1 channel relay which is a switch to turn on or turn off UV C. Notation number 5 is a PIR sensor which is a sensor that detects the movement of objects. Notation number 6 is a buzzer used to indicate when an object is detected by the PIR sensor. Notation number 7 is a UV C lamp used for sterilization because it can kill and damage bacterial cells

The micro-USB port in the picture is used to connect the device to the laptop. Then to run the tool, a source program is needed that is useful for managing data transmission. Sending data is using wifi as a network. The output of the tool is a sensor reading value that has been processed through the Arduino IDE and displays a graph containing the sensor reading value on the platform.

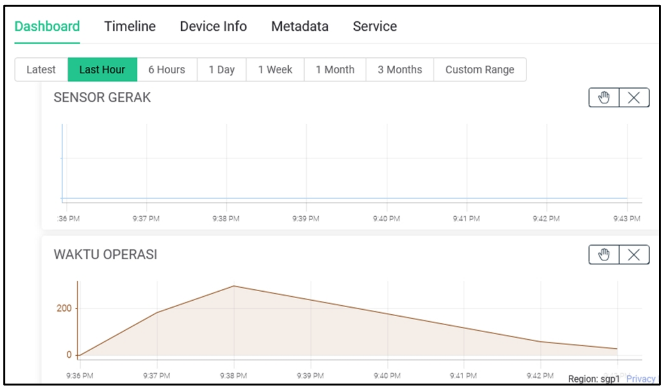

FIGURE 5. Graph of time data and PIR sensor web platform blynk

In FIGURE 5. the initial view of the blynk platform used to operate the sterilization system and is used to monitor sterilization.

1

2

4

3

5

FIGURE 6. Time Graph and PIR Sensor on the Blynk Smartphone Application

In FIGURE 6,, there are several devices that are used and have the following functions; notation number 1 is a PIR sensor graph; the graph will be worth 1 when it detects an object. Notation number 2 is a graph of the sterilization time, the graph will be worth 1 as long as the sterilization takes place. Notation number 3 is used to see if the UV lamp is on, the system is working and whether the PIR sensor detects the object. Notation number 4 is used for setting the sterilization time. Notation number 5 is used to reset sterilization settings and reset access point settings

B. MONITORING BACTERIAL STERILIZER SYSTEM

Monitoring the bacterial sterilizer system using a Blynk platform can operate the sterilization system. In this system the view the sterilization time graph and view the PIR sensor graph can be monitored. There are 3 conditions, namely the condition of 1 sterilization without objects, the condition of 2 objects being detected 1 time, and the condition of 3 that objects is being detected after coming back to the room.

1. CONDITION 1 SYSTEM WITHOUT OBJECT

In this condition, sterilization is carried out without any object being detected, aiming to find out whether the sterilization is running according to the specified time (TABLE 5).

TABLE 5
Sterilization conditions 1

Test	Sterilization Time	PIR sensor	Information
1	6.05.37 - 5.20.37	-	No Object Detected
2	6.24.53 - 6.39.53	-	No Object Detected
3	6.44.04 - 6.59.04	-	No Object Detected
4	7.00.51 - 7.15.51	-	No Object Detected
5	7.17.48 - 7.32.48	-	No Object Detected
6	7.34.53 - 7.49.53	-	No Object Detected
7	7.52.00 - 8.07.00	-	No Object Detected

2. CONDITION 2 DETECT OBJECT 1 TIME

In this condition, sterilization is carried out by detecting the object once, aiming to ensure whether the sensor can detect the object during the sterilization process (TABLE 6).

TABLE 6
Sterilization condition 2

Test	Sterilization Time	PIR sensor	Information
1	8.11.00 - 8.26.21	8.18.40 - 8.19.01	Objects Detected 1 Time
2	8.30.22 - 8.45.43	8.38.51 - 8.39.12	Objects Detected 1 Time
3	8.56.43 - 9.12.04	9.08.50 - 9.9.11	Objects Detected 1 Time
4	7.18.21 - 7.33.46	7.28.12 - 7.28.36	Objects Detected 1 Time
5	8.56.38 - 9.12.04	8.02.33 - 8.02.59	Objects Detected 1 Time
6	8.13.42 - 8.29.05	8.22.48 -8.23.11	Objects Detected 1 Time
7	8.31.47 - 8.47.09	8.38.20 - 8.38.42	Objects Detected 1 Time

3. CONDITION 3 DETECT WHEN OBJECT LEAVING AND COME BACK TO THE ROOM)

In this condition aims to ensure the sensor can stop the system when it detects the object during sterilization (TABLE 7).

TABLE 7
Sterilization condition 3

Test	Sterilization Time	PIR sensor	Information
1	8.49.49 - 9.05.31	8.54.30 - 8.54.51 and 8.59.50 - 9.00.11	Object detected 2 times
2	9.07.51 - 9.23.33	9.13.33 - 9.13.54 and 9.18.48 - 9.19.09	Object detected 2 times
3	9.25.39 - 9.41.21	9.34.31 – 9.34.52 and 9.37.09 - 9.47.30	Object detected 2 times
4	9.50.48 - 10.06.30	9.58.38 - 9.58.59 and 10.02.22 - 10.02.43	Object detected 2 times
5	10.08.01 - 10.23.41	10.17.53 - 10.18.13 and 10.21.03 - 10.21.23	Object detected 2 times
6	10.41.43 - 10.57.26	10.45.44 - 10.46.06 and 10.51.54 - 10.52.15	Object detected 2 times
7	10.59.31 - 11.15.13	11.03.45 - 11.03.06 and 11.09.35 - 11.09.56	Object detected 2 times

C. BASED TOOL TOUGHNESS TESTING ISO 17025 AND QOS

Measurement quality assurance testing is carried out to determine the stability of the tool's performance and the feasibility of the tool, quality assurance of measurement adapting or reference from ISO 17025, namely:

1. SENSITIVITY

The response of the tool when it detects an object. For example, during sterilization this tool can detect objects several times in one sterilization period

2. SELECTIVITY

This tool can detect objects (Adults, Cats) as shown in TABLE 8.

TABLE 8
Selectivity

Object	Information
Adults	Detected
Cat	Detected

This experiment was conducted to determine whether the sensor can detect adults and cats, the experiment was conducted with 2 objects with different sizes to determine whether the sensor can detect objects with different sizes.

3. PRECISION

This measurement is carried out by taking 7 data from 1 object with 3 conditions to determine whether the sterilization is running according to the specified time and the sensor can detect the object accurately (TABLE 9).

TABLE 9
Repeat sterilization

Condition	Loop						
	1	2	3	4	5	6	7
1	✓	✓	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓	✓	✓
3	✓	✓	✓	✓	✓	✓	✓

In table 9 condition 1 goes well where the sterilization time is 15 minutes and the PIR sensor does not detect any object movement, condition 2 runs well on loop 1,2,3 sterilization time 15 minutes 21 seconds , on repeat 4 the sterilization time is 15 minutes 25 seconds, on loop 5 the sterilization time is 15 minutes 26 seconds, on loop 6 the sterilization time is 15 minutes 23 seconds, on loop 7 the sterilization time is 15 minutes 2 2 seconds , the PIR sensor detects 1 time movement of the object, and condition three went well where the sterilization time on iterations 1,2,3,4,7 for 15 minutes 42 seconds , on repetition 5 sterilization time for 15 minutes 40 , on repetition 6 sterilization time for 15 minutes 4 3, the PIR sensor detects movement 2 times .

4. WORKING RANGE

The extent to which the sensor can detect objects. The TABLE 10 shows that the PIR sensor can detect objects at 1m, 1.5m and 2m.

TABLE 10
PIR Sensor Detection Distance

Range	Information
1 Meters	Detected
1,5 Meters	Detected
2 Meters	Detected

5. TOOL TOUGHNESS

This tool works well, the sterilization runs for a predetermined time and the PIR sensor can detect objects at the time of sterilization.

6. UNCERTAINTY

This tool can detect objects (Adults) with three different people. The TABLE 11 shows that the PIR sensor can detect different objects (Adults).

TABLE 11
Uncertainty

Object	Information
Adults 1	Detected
Adults 2	Detected
Adults 3	Detected

7. DELAY ANALYSIS

Delay testing aims to determine the time required by the packet sent to arrive at the recipient. This will repeat itself after the packet has been received by the sender. Delay can be determined by dividing the amount of delay by the number of packets sent.

TABLE 12
Delay Test Results

Test	Delay (ms)	Category
Test 1	89	Very good
Test 2	138	Very good
Test 3	139	Very good

Delay test in this system aims to determine the lag time required in a packet delivery. TABLE 12 is the data resulting from the measurement of delay from 3 experiments that have been carried out using Wireshark software. From the tests that have been carried out, the delay in the first experiment was 89 ms, the second experiment was 138 ms , and the third experiment was 139 ms. The delay is also influenced by the internet connectivity used, but in the 3 trials it was relatively stable with a small delay difference.

8. THROUGHPUT ANALYSIS

Throughput is the average speed of data received in a certain time interval. Throughput can also be said as the rate of successful message delivery through a communication channel. Throughput is usually measured in bits per second (bit/s or bps), and sometimes also in data packets per second (p/s or pps) or data packets per time slot (TABLE 14).

TABLE 14.
Test Results Throughput

Test	Throughput (byte/s)	Category
Test 1	1326	Very good
Test 2	822	Very good
Test 3	988	Very good

Throughput parameter in 3 trials. The results of the throughput in the first experiment got a value of 1326 byte/s , the second experiment was 822 byte/s, and the third experiment is 988 bytes/s from the 3 experiments that have been carried out, it can be seen that the sterilization monitoring system in the program can send data very well to the platform Blynk. It is because the larger the data sent, the higher the throughput.

9. PACKET LOSS ANALYSIS

Packet loss is the amount of data lost during the data delivery process caused by data collisions (collision), network capacity and packet decline due to the expiration of packet waiting times. Measurement of packet loss using internet network media, the quality and speed of the internet used will affect the results obtained.

TABLE 15
. Packet Loss Test Results

Test	Packet Loss (%)	Category
Test 1	0,2	Very good
Test 2	0	Very good
Test 3	0	Very good

TABLE 15 shows the data generated for the packet loss parameters in the 3 tests carried out. In the first test the packet loss value is 0.2%, the second test is 0 %, and the third test is 0%. From the results of the packet loss test obtained, it can be categorized as very, from the 3 experiments carried out all of them got a packet loss value of 0%.

IV. DISCUSSION

Smart sterilization room is needed to reduce the damage of bacteria. This tool provides the scenario to make the room healthy and bacterial free. The first scenario is when the room without objects. In this first case, the system must be running to sterilize the location. In Table 4.1. the system is run for 7 experiment to sterilize the object when the object is not in the room. At the second scenario, the system must recognize the object who enter to the room. For the safety reason, the tools are required to turn off the sterilization when detects the object. It has been reported that in Table 4.2. that the system also successfully accomplished the duty. The last scenario is when the object is leave to the room but suddenly enter the chamber. In 7 consecutive experiment the system always responds the object.

At the quality assurance perspective, the ISO 17025 has been adapted to see the measurements of this system. The system shows that this tool can distinguish object and sensitive. This result also has good precision regarding the time responds and has can detect three different object that report its uncertainty parameter. Regarding quality of services, delay, packet loss, and throughput is in very good category showing that this tool is promising based on working system and robustness. Based on the QoS test, the 4 categories which are very satisfying. Regarding the guarantees the quality of the reference, measurement from ISO 17025 included in the eligible categories has successfully carried out the test. Limitation of this research is that the experiment conducted in 3m x 3m chamber and using one lamp. In bigger room such as common office room the system should be work in more complex scenario. Furthermore, there was no experiment in this project proofing that the bacteria are vanished. However, this research follows the report that based on reference that the UV will kill the bacteria in certain dose[24][25].

V. CONCLUSION

This study aims to build monitored sterilization room which can serve practicable scenarios and has assurences regarding its function Based on the test results data, analysis and discussion regarding builiding of monitoried anti-bacterial anti-bacterial room sterilization system based on internet of things using PIR sensor, the tool could be operated and monitored using Blynk in real time. There was a security system using a PIR sensor that can stop the sterilization process when an object is detected. The test was carried out by taking 7 data from 1 object with 3 conditions, to find out whether the sterilization system is running well according to the specified time and the PIR sensor can detect objects during sterilization.

Quality of service on QoS testing in anti-bacterial intelligent room sterilization system got an average delay of 122 milliseconds, throughput of 1045 bits/s and packet loss of 0.06%. Based on reference measurement quality assurance from ISO 17025; (1) Sensitivity: This tool could detect objects several times in one sterilization period. (2) Selectivity: The tool could distinguish between adult objects and cats. (3) Precision: This tool could run according to a predetermined time and the sensor can detect objects accurately, measuring done by taking 7 data from 1 object with 3 conditions. (4) Working range: This tool could detect objects at 1m, 1.5m, and 2m. (4) Toughness: This tool was quite tough in sterilizing the room because the sterilization runs according to a predetermined time and the PIR sensor can detect objects during sterilization. (5) Uncertainty: This tool could detect objects (Adults) with three different people.

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