Indonesian Journal of Electronics, Electromedical Engineering, and Medical Informatics
Multidisciplinary : Rapid Review : Open Access Journal Vol. 5, No. 1, February 2023, pp.1-12 e-ISSN: 2656-8624

RESEARCH ARTICLE OPEN ACCESS

Manuscript received December 31, 2022; revised January 21, 2023; accepted February 02, 2023; date of publication February 25, 2023
Digital Object Identifier (**DOI**): https://doi.org/10.35882/ijeeemi.v5i1.256

How to cite: Dewi Sekar Arum,Danny Kurnianto,Muhammad Yusro, "IoT-Based Medical Box Improvement for The Elderly Adapting ISO 17025 and Quality of Service", Indonesian Journal of Electronics, Electromedical Engineering, and Medical Informatics, vol. 5, no. 1, pp. 1–12, February. 2023.

IoT-Based Medical Box Improvement for The Elderly Adapting ISO 17025 and Quality of Service

Dewi Sekar Arum[1], Danny Kurnianto[2], and Muhammad Yusro[3]
[1] Telecommunication Engineering Study Program, Institut Teknologi Telkom Purwokerto, Indonensia
[2] Telecommunication Engineering Vocational Study Program, Institut Teknologi Telkom Purwokerto, Indonensia
[3] Biomedical Engineering Study Program, Institut Teknologi Telkom Purwokerto, Indonensia

Corresponding author: Muhammad Yusro (e-mail: yusro@ittelkom-pwt.ac.id).

ABSTRACT Elderly is a period characterized by limited movement functions in the body. Elderly with multiple comorbidities have a higher risk of non-adherence because receiving more than one type of drug is more susceptible to skipping medication hours so that the elderly need reminders and drug storage areas to maintain drug quality. The main objective of this research is to emerge the robust medical box which gives notification and could be monitored suited to elderly purposes. This research was carried out with Arduino Uno as the control center of the system and using the ESP8266 Wi-Fi module for internet connection. This system uses a DHT-22 sensor, an HW-201 IR sensor and a servo motor. Tool standardization is also carried out through method validation adapting ISO 17025 and network-related Quality of Service (QoS). The results show that the system can work according to the command with an alarm notification on the android application when the clock shows the time to take medicine. Based on the DHT 22 sensor test, by measuring the temperature and humidity, the bias value is 0.318% and the trueness value is 99.7%. This Medical Box tool also has an acceptance limit precision of 83%. Based on the QoS network testing according to THIPON, the network quality is categorized as very good for throughput of 5241 Kbps, packet loss of 0%, delay of 136.5 msec, and jitter of 21.28 which are categorized as very good. This study designed a system to make it easier for the elderly as a reminder of the schedule for taking medication as well as a place to store drugs that can maintain the quality of drugs.

INDEX TERMS Medical Box, Elderly, IoT, ISO 17025, QoS

I. INTRODUCTION

Elderly is a period characterized by limited movement functions in the body which is characterized by decreased intellectual and physical abilities [1] . The elderly have a higher risk of non-adherence because they take more than one drug [2] . The development of medicine boxes, including medical boxes, is a device that is useful in helping the elderly take their medication on time according to a doctor's prescription and can monitor the health of the elderly [3].

In the era of electronic development in today's technology era, there have been several studies regarding the development of electronic devices, one of which is a drug storage area that has been designed to make it easier for users who have to take many types of drugs on a daily basis with various shapes, colors and drug sizes [3]. The development of medicine boxes, including medical boxes, is a very useful device in the healing or maintenance process health, helping the elderly take medication on time according to a doctor's prescription and being able to monitor the health of the elderly. The medical box is designed as a user-friendly system where a person uses a tool, software or system that can be operated easily which aims to make it easier for the elderly to use it.

In previous research on smart medical analysis based on the Internet of Things , it showed that the medical box that had been designed had not been tested as a whole, including the

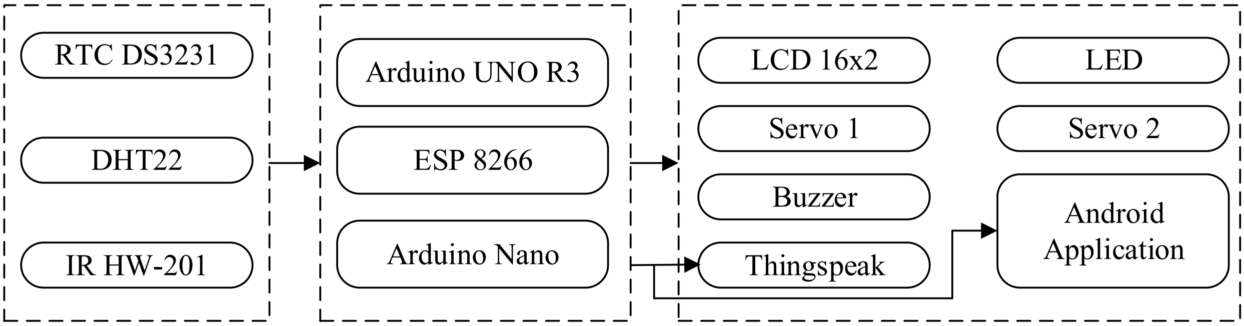

FIGURE 1. Diagram block of medical box system

toughness of the tool [4] [5][6] . Therefore, this study will test the toughness of the medical box so that it can function properly using ISO 17025 standardization parameters using method validation, namely sensitivity, selectivity, accuracy, precision, warning range at the Limit of Detection (LoD) on the medical box.

This medical box system is a research study on the Internet of Things and the smart things domain showing how the different elements of people's daily activities are becoming increasingly interdependent on one another. The control system on the medical box is designed using Arduino Uno as the control center of the system and uses the ESP8266 Wi-Fi module to communicate with the microcontroller and an internet connection so that it monitors the elderly taking medication and monitoring the temperature in the medical box. This system uses the DHT-22 sensor to measure the temperature in the box, the HW-201 IR sensor as an automatic counter of the amount of medicine in the medical box and a servo motor which will automatically open and close the exit for the medicine tube. Monitoring of medication taking schedules and temperature is carried out through the Thingspeak platform which can be accessed by doctors and monitoring using alarm message notifications to make it easier for patients to be reminded of medication schedules.

Emerging the robust medical box which could give notification and reminder is essential to modern life concerning that some elderly has dementia. This system provides great advantages such as: (1) assisting elderly's child to assist their parents regarding drugs schedule. (2) Maintaining the quality drugs concerning their temperature and humidity requirement. (3) By integrating IoT platform and mobile application, the monitoring regarding the requirement of elderly's drugs could be observed in real time fashioned.

II. METHODS

A. MEDICAL BOX DESIGN

Medical box designed using several components, namely the IR sensor which will function to read the drug tube object that will come out and give orders to the servo to open the drug tube exit gate. Furthermore RTC (Real Time Clock) to display the time in real time. All the input above will be processed by the Arduino Uno and Arduino Nano microcontrollers. The ESP8266 Wi-Fi module functions as a Wi-Fi network to connect android and Thingspeak web. If the system is turned on, the LCD will display the words "Medical Box" then connect to Wi-Fi. Schematically the block diagram of the medical box system is shown in FIGURE 1.

It could be seen in FIGURE 1 that the input consists of three components which are RTC D5 3231 (AT 24C32/Si Tai&SH/China) as a timer, DHT 22 (AM2302b/ AOSONG Electronic/ China) for sensing temperature and humidity, and IR HW-201 (Mh-b/fuyuanxin/China) for detecting drugs. On process system, this tool has three main parts including Arduino Uno R3 (ATMEGA328/T119-L2D23/Italy) as microcontroller board, ESP 8266 (ESP-01/Espressif/China) as Wi-Fi Module, and Arduino Nano (ATmega328P/ Gravitech/Italy) knowing as smallest microcontroller board. As output there are six components that are provided in this tools which are LCD16x12 (HD44780 / DSP-0052/ China) as display unit, Servo 1 and 2 (DC-Sg90/Tower Pro/South Korea) as opener the gate, buzzer (Piezo/Japan) as notification, LED as indicator, Thingspeak (USA) which has functions to collect, store, analyze, visualize and act on data from hardware sensors or actuators such as Arduino and other, and Android Application (MIT App Investor/USA) which can design the user interface.

In this system, if it is time to take the medicine, the buzzer will sound, and the servo will open so that the medicine will be dispensed automatically. Then the LCD will display a description of the time to take the medicine. If the drug runs out, the infrared sensor cannot detect the drug, the red LED will light up and vice versa if the medicine is still there, the green LED will continue to light up. The DHT 22 sensor functions as a medical box temperature and humidity monitoring which will be sent to the Thingspeak web and will be displayed on the LCD screen.

1) HARDWARE DESIGN

Visual design of medical box equipment is a medical box hardware design to find out the description that has been made.

This design uses the Tinkercad 3D Design platform. As explained in Figure 2 namely there are several components that have their respective functions. The figure shows some of the components used in the Medical Box, namely green led, red led, buzzer, LCD, drug input box and drug output box. Next, enter the hardware design stage of the schematic circuit on the Medical Box. FIGURE 2 shows a medical box design in isometric view.

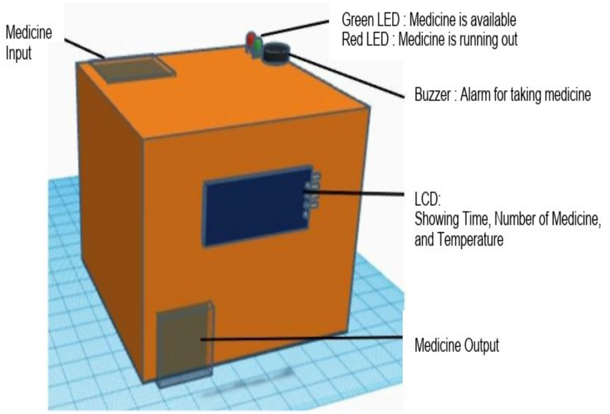

FIGURE 2. Visual Design of Medical Box Equipment

The components in this system are connected to each other with Arduino Uno and Arduino Nano. Arduino Uno is the brain of the entire circuit that gets DC voltage from a 12V power supply. This voltage will be given to the Arduino Uno and Arduino Nano boards so that the system can all work, after that Arduino Uno will process data from several sensors used so that the power results will be displayed on the 16X2 LCD.

2) SOFTWARE DESIGN

The design of the software in FIGURE 3 shows that before the system works, a variable is initialized which functions to determine the initial value when declaring it. After initializing the variables, the system will read the RTC, which is the predetermined time to take the drug. If the time for drug administration is appropriate, the alarm on the buzzer will sound, otherwise the system will read back the RTC sensor time in real time. Then servo 1 will rotate to open the drug tube exit path and the Infrared sensor will read the medicine tube object that comes out, the DHT 22 sensor will read the temperature and humidity in the medical box. If the IR sensor reads the drug tube object, the green LED lights up and servo 2 will open automatically, if the Infrared does not read the object, the red LED will light up indicating that the medicine tube in the medical box has run out. When servo 2 opens, an alarm will sound to indicate that the medicine tube has come out. Then, the LCD will display the serial "time to take medicine" then after 1 minute it will display temperature and humidity data on the LCD serial and send data received by DHT-22 to be processed on Arduino Uno which will then be sent to Thingspeak to monitor the condition of the medicine tube on Medical box. After the medicine tube comes out there will be an Alarm notification on the user's android application with an interval of sending notifications for 1 minute after the medicine tube comes out.

Android application design based on MIT App Inventor is used as an alarm reminder for taking medication. The system will initialize global variables which function to determine variable values when declaring WiFi devices. Then the system will read real time data from Thingspeak. When sending data from Thingspeak to the android application, wait for a delay of 1 minute. The android application will display temperature and humidity data on the user's cellphone screen and the status of the reminder to take medication, whether the status sends "open" then the alarm notification will sound with the status "time to take medication" but if the status is "standbay" then the application waits for the real time to take the medicine has been determined.

B. STANDARDIZATION OF MEDICAL BOXES

1) METHOD VALIDATION ACCORDING TO ISO 17025

ISO 17025 is used so that the method used is valid, this method includes sensitivity, selectivity, accuracy, precision, working range and tool toughness [7] [8] [9] . Method validation is confirmation through testing and providing objective evidence that certain requirements are for a purpose and as important information for assessing the capabilities as well as the limitations of a tool to be tested. Sensitivity measurements on the DHT 22 sensor compared to the Standard Thermo-Hygrometer device yield significant values that are almost the same between the DHT 22 sensor. Researchers measured 3 different temperature conditions, namely, to determine the value of temperature and humidity as one of the capabilities of the medical box not only for monitoring the elderly taking their medicine on time but also for monitoring the condition of the drugs in the medical box so that the quality of the medicine is maintained.

1). SENSITIVITY

Sensitivity can be interpreted as the response of the tool to detect changes in values when measuring to see the accuracy of reading objects. In this tool, if the resulting value is closer to the value of the comparison tool, the tool used is more sensitive.

2). SELECTIVITY

Selectivity is a tool that can distinguish the value of the measurement object from the desired value. Experiments are needed to determine whether the tool can detect objects. In this case the object is time, where the tool will be set in time to prove this tool is time selective. The selectivity measurement on the medical box refers to the servo motor and Infrared sensor in reading the medicine tube and testing the selectivity of the drug output clock which will be tested for the same

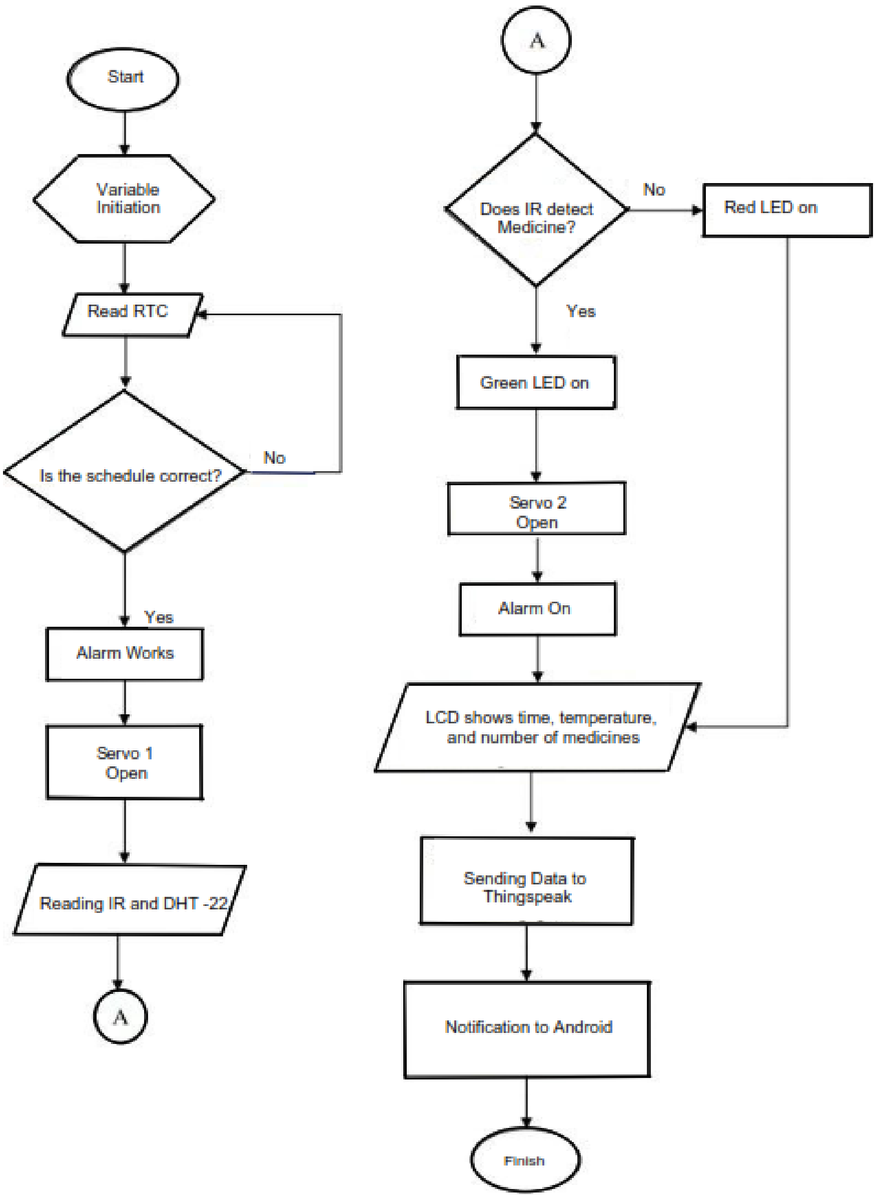

FIGURE 3. **Medical box software design flowchart**

repetition time for 7 times with a time span of one hour at one minute. It can be seen in table 4.5 the results of the selectivity test on the servo motor and IR sensor in reading the time and medicine tube.

3). ACCURACY

To determine the accuracy of the tool being tested, a comparison tool is needed to calculate the value of the range of the comparison tool with the designed sensor value. Accuracy equation formula using trueness and bias calculations.

Trueness equation formula [7] :

$$\text{Trueness} = |X / \mu| \times 100\% \quad (1)$$

Bias equation formula [7] :

$$\text{Bias} = |(X - \mu)/\mu| \times 100\% \quad (2)$$

Bias value is the comparison of the difference in the average value of the test results with the CRM value, namely the value obtained from the measurement results of a standard comparison tool, if the bias value obtained is close to 0%, the bias value can be said to be close to the standard [7] . Accuracy is the closeness of the measured value to the actual value limit in a sample matrix (accepted true value) of the servo motor to the time that is set with the servo reading time. It can be seen from the tests carried out with a span of 5 minutes testing the output of the drug tube automatically, testing is carried out every one hour with 7 repetitions.

4). PRECISION

Precision parameter measurements are made from several measurements. Data measurement takes the difference in the comparison value of the DHT 22 sensor tool with the Hygrometer tool. Then find the average and standard deviation of the test data. This power result calculates the value of the difference in temperature measurement results. The closeness of the measurement values for 30 temperature and humidity data in the medical box is calculated by the average measurement of the difference between the DHT 22 sensor and the Standard Thermo-Hygrometer.

5). WORKING RANGE

Working Range is the ability of the tool to determine the desired range value at the time of measurement. In this study, there are factors that can affect the results of the study, namely the limit of detection (LoD) which is the detection limit on the device to be tested, such as the lowest and highest limits on drug discharge time. The detection limit is the lowest value of a device or system that can be measured. This test will be carried out as many as 30 measurement data at each test time. The measurement of the limit of detection time is measured from the shortest time to the longest time in the Medical Box. The working range of the servo motor to determine the work level of the servo is carried out for 3 minutes once the servo motor has been tested to function as opening and closing the drug exit pathways. This proves that the servo is accurate to the time limit set.

6). TOOL TOUGHNESS

Testing the toughness of the Medical Box tool has been tested for system endurance for 7 hours the system is on, but there are several factors that make the Medical Box tool reset the system, such as a stable Wi-Fi network so that Arduino Uno sends a signal to the RTC sensor so that it can display the clock that has been set for out of the medicine tube.

2. QUALITY OF SERVICES (QOS)

Quality of Service (QoS) is defined as a measurement of how good a network is and is an attempt to define the characteristics and nature of a service. QoS refers to the ability of a network to provide better service to certain network traffic through different technologies [10] . The QoS measurement parameters used are:

1). Throughput

Throughput is the number of successful packet arrivals within a certain time with bps (bits per second) or can be interpreted as the effective data transfer speed measured in bps units [12] . Throughput is the actual bandwidth received by the user. Throughput is calculated using the following formula amount of data sent divided by data delivery time [13]. For QoS standardization, THIPON (Telecommunications and Internet Protocol Harmonization) standardization is used. Throughput categories are shown in TABLE 1.

TABLE 1
Category Throughput by TIPHON [13]

Category	Throughput %	Index
Very Good	100	4
Good	75	3
Average	50	2
Bad	< 25	1

2). Packet loss

Measurement of packet loss using the internet network, the quality and speed of the internet used will affect the value of the packet loss measurement obtained. Packet Loss is a parameter that describes a condition indicating the total number of lost packets that can occur due to collisions and congestion on the network [15] . This parameter is calculated using the following formula Packets sent-packets received divided by data packets sent times 100% [13] .

The results of the packet loss value are said to be good if the results obtained are 0% and are categorized as bad if the packet loss value is> 25% according to the THIPON standard. Packet loss categories are shown in TABLE 2.

TABLE 2
Packet loss categories by TIPHON [13]

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

3). Delays

Delay is the total time that a packet passes from sender to receiver over the network. Delay from sender to receiver is basically composed of Hardware latency, access delay and transmission delay. This parameter can be affected by distance, physical media, congestion or long processing time [16] . delays calculated using the following formula time package received-time package sent divided by number of packages received [13] .

TABLE 3
Category of Delay by TIPHON [13]

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

Testing the delay (latency) aims to determine the time needed by the data packet sent to arrive at the recipient. This will be repeated after the packet has been received by the sender. The delay category is shown in TABLE 3.

4). Jitter
Jitter is usually called delay variation because it is closely related to delay which shows the number of delay variations in data transmission on the network. Jitter calculated using the following formula total variation delay divided by total packet achieved [13] .

Jitter is caused by variations in queue length, data processing time and packet reassembly time at the end of the trip. jitter category shown by TABLE 4.

TABLE 4
Jitter category by TIPHON [13]

Category	*Delay* (ms)	Index
Very Good	0 ms	4
Good	0 ms – 75 ms	3
Average	75 ms – 125 ms	2
Bad	125 ms – 225 ms	1

III. RESULT

A. DESIGN RESULTS

Medical box helps the elderly to take medicine according to the schedule set by the doctor. FIGURE 4 shows the appearance of the medical box. The LCD screen will display the clock in real time, the temperature and humidity in the medical box, and the amount of medicine. When it is time to take the medicine, the buzzer will sound then servo1 will open automatically followed by the medicine tube coming out and the Infrared sensor will read the object in front of it which gives a signal that the green LED lights up indicating that there is medicine that will come out, after IR reads, servo2 will open automatically and the buzzer sounds for the second time, it indicates that the drug has been successfully released at the specified time. If the medicine in the medical box has run out, the buzzer will sound once because the IR sensor does not read objects that pass and the servo will not open automatically, then the red LED lights up. The medicine tube in the *medical box* is filled manually by the user. After the medicine tube comes out, the alarm notification on the android application user enters to monitor the schedule for taking elderly medicine regularly and as a sign that the *medical box system is* running well, but there is a delay of 1 minute for delivery to Thingspeak as monitoring of temperature and humidity in drugs that can be monitored by the doctor so that the medicine is stored and the temperature is maintained properly in the tube according to the standards of the Indonesian Pharmacopoeia in storing medicines properly so that their quality is maintained.

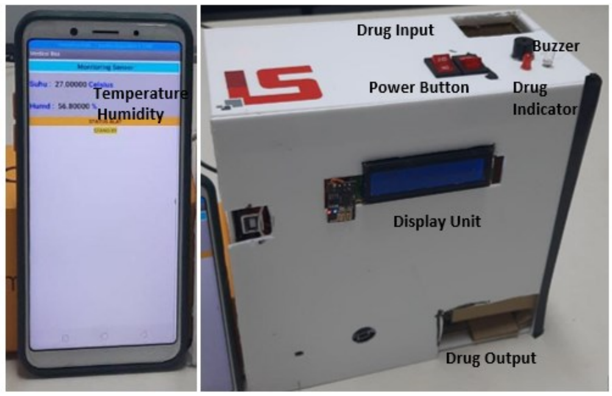

FIGURE 4. Display of the medical box for the elderly

In testing the DHT-22 sensor which is used to monitor and measure the temperature and humidity in the medical box. FIGURE 5 shows the results of the monitoring. Research Testing this sensor is carried out to function to maintain the

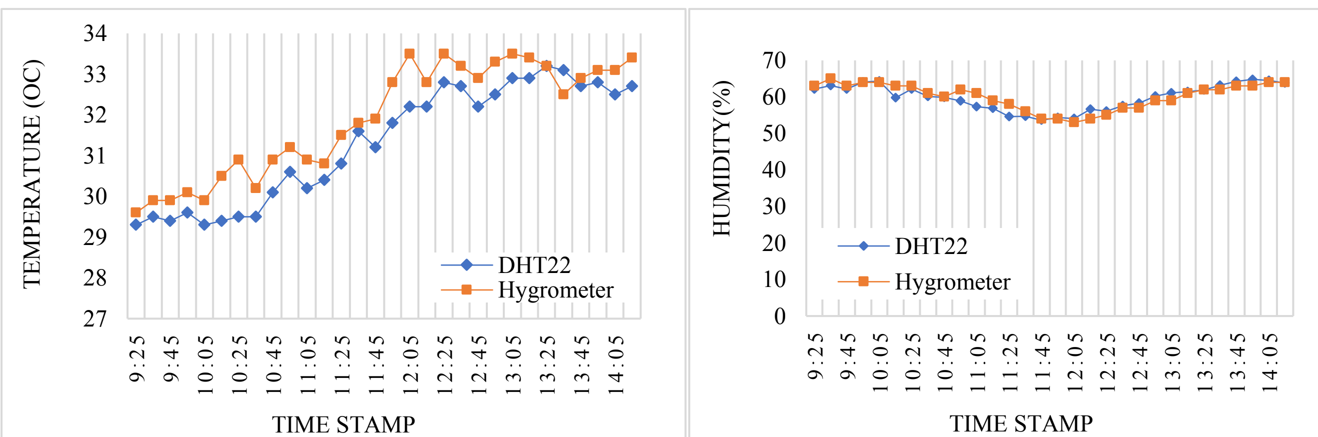

FIGURE 5. Monitoring temperature and humidity

humidity of the drug in the tube so that the drug is always in good condition and prevent the risk of drug degradation which will damage the quality and safety of the drug. To keep drugs safe, they should be stored at standard temperature conditions in a cold room, around 8-15 °C or at room temperature conditions around 30 °C [4].

B. ISO 17025 METHOD VALIDATION

1). SENSITIVITY

Testing the sensitivity of the tool to determine the response of the sensor to changes in temperature and humidity values in the medical box at the time of measurement. The measurement results from the DHT 22 sensor and Hygrometer obtain temperature and humidity values for each condition which can be seen in TABLE 5.

TABLE 5
Comparison Results Condition Test Temperature and Humidity

Room Condition	Temperature			Humidity		
	DHT-22	Hygrometer	Error (%)	DHT-22	Hygrometer	Error (%)
Room	28.65	28.66	0.0003	74.8	73.2	0.021
Cooler	24.65	24.33	0.013	50.81	52.73	0.037
Outside	31.32	31.90	0.018	59.86	60.10	0.004

Sensitivity measurements on the DHT 22 sensor compared to the Standard Thermo-Hygrometer tool yield significant values that are almost the same between the DHT 22 sensor and the Thermo-Hygrometer.

2). SELECTIVITY

Testing for one hour past one minute proved that the servo is selective with the time it is set, and the infrared sensor can read the medicine tube that comes out automatically in the medical box. ISO 17025 standardization testing is carried out 7 repetitions per hour to prove the system can withstand time.

TABLE 6
Selectivity test results

Time Stamp	Servo 1	Infrared	Servo 2
15:01	√	√	√
16: 01	√	√	√
17: 01	√	√	√
18: 01	√	√	√
19: 01	√	√	√
20: 01	√	√	√
21: 01	√	√	√

Based on TABLE 6, from the 7 repetition data samples with a time difference of 1 hour past 1 minute 2 servo motors and Infrared sensors can be said to be selective in terms of drug output time. Servo motors and infrared sensors can work according to the hours set in the source code.

3) ACCURACY

Accuracy analysis was carried out by measuring the accuracy of the DHT 22 sensor with a standard hygrometer to determine the accuracy of the sensor in the *medical box.* Based on the calculations in TABLE 7, the trueness measurement accuracy value was 99.7% and the bias value obtained was 0.318%. The trueness and bias values obtained have very good value accuracy. The value obtained from the calculation of the accuracy of the sensor test used with a comparison tool is significant.

TABLE 7
Results testing accuracy sensors DHT22

Measurement	Temperature		Humidity	
	DHT-22	Hygrometer	DHT-22	Hygrometer
1	28.65	28.66	74.8	73.2
2	24.65	24.33	50.81	52.73
3	31.32	31.90	59.86	60.10
Mean	28.21	28.30	61.82	62.01

4) PRECISION

The closeness of the measurement values for 30 temperature and humidity data in the medical box is calculated by the average measurement of the difference between the DHT 22 sensor and the Standard Thermo-hygrometer. The average value of the difference in standard deviation is calculated to determine the range of quality grade values at temperature and humidity that are obtained outside the standard limits or not.

FIGURE 6 shows the data area with Acceptance limit conditions colored green is acceptable, warning limit conditions seen in yellow and out control conditions red are data that cannot be accepted. Precision standard deviation measurement with a standard deviation value of 0.324. The calculation of the standard deviation value of the temperature Acceptance limit is in the range of 0.6, 0.9 and 0.2. The value is calculated using the equation formula (2), namely the calculation of the average difference value.

Averaged by adding the standard deviation 3 times and subtracting the standard deviation 3 times. The value of 0.6 is the standard deviation value, the value of 0.9 is the value added to the acceptable standard deviation and 0.2 is the reduction in the acceptable standard deviation or acceptance limit. The warning limit for the difference in the value of the two measurement tools of 1.2 can be caused by the value of several causal factors between the two sensors and the Hygrometer has a comparison of the resulting difference values. Moisture precision graph with a standard deviation value of 2.0. The deviation value of 4.0 is the acceptance limit value, which is the limit on the added value of the standard deviation and the value of -0.03 is the reduction in the value of the standard deviation with the line acceptance limit or acceptable value limit. The calculation of the standard deviation must add values and reduce the value of the standard deviation by 3 calculations. The maximum deviation value is 8.02 and the minimum deviation value is -4.06.

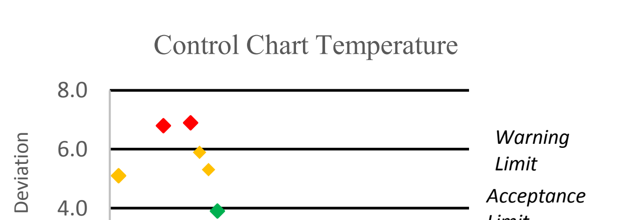

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FIGURE 6. Graph of Precision Standard Deviation of Temperature and Humidity

5). WORKING RANGE
Servo motor measurements are carried out with the aim of finding the limit of detection at time to find factors that can affect the value of the measurement results. In this measurement various reasons can lead to systematic errors, such as measurement techniques, environmental conditions, equipment damage, etc. Systematic error will affect the accuracy of a measurement result.

6). TOUGHNESS
The medical box system has been tested for the toughness of the tool by operating the system for ± 7 hours of research between the DHT 22 sensor for monitoring temperature and humidity inside the medical box, a servo motor that can open the clock that has been set and an IR sensor that can read medicine tube objects. If an error occurs such as Arduino Uno resetting the system again indicating that the Wi-Fi network used is unstable, then the user can check the Wi-Fi network and the LCD will display serial connecting on the screen to tell whether it is connected to the network or not.

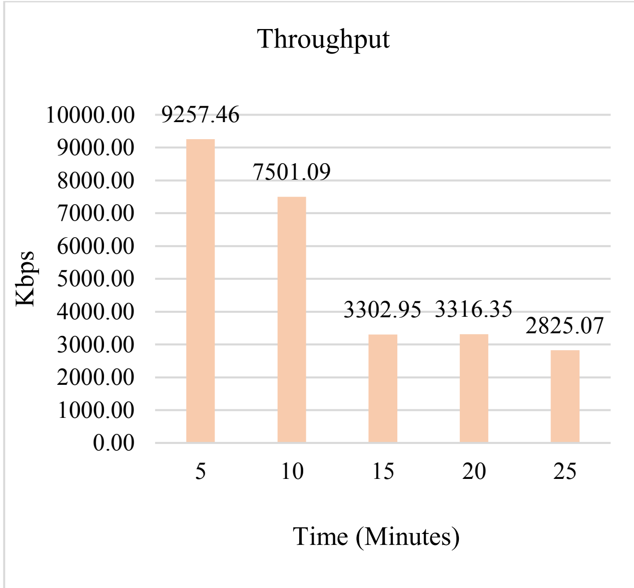

FIGURE 7. Graph of Throughput Value Measurement Results

C. QoS TEST RESULTS
The results of service quality testing are carried out by capturing the display of data results that have been processed by Wireshark.

1). THROUGHPUT
FIGURE 7 shows the measurement of throughput values. The largest value measurement is 92996.4 bps with a span of 5 minutes the number of successful packet arrivals and the lowest throughput value is in the span of 25 minutes which is 2825.074 bps. The value of the number of data transmissions is taken from the bytes value then divided by the Time span value, the measurement of this value can be seen on the captured Wireshark, the result of dividing the value is multiplied by 8 to change the value of bytes to bits, because 1 byte = 8 bits. FIGURE 7 shows the results of measuring throughput values.

2). PACKET LOSS
Packet loss obtained an average value of 0% where the measurement results are included in the very good packet loss measurement category with an index value of 4. Packet loss value measurements are carried out at the same hour to produce good and precise measurement values. Table 8 shows h result testing package loss.

TABLE 8
Packet loss test results.

Times (Minutes)	Number of Packet Sent	Number of Packet Achieved	Packet Loss
5	5272	5272	0
10	8514	8514	0
15	5238	5238	0
20	6992	6992	0
25	7070	7070	0

3). DELAYS

The total delay is the sum of all delays in packets when transferring data by reducing the value of time 2 by time 1, or it can be seen in the capture results of the Time span properties file on Wireshark, while the number of packets is the number of packets that arrive during data transfer. The value of 34.6 is the delay calculation value with an index value of 4 which is very good in the 5-minute time span. The delay value in the 25-minute timeframe is 42.6 with an index value of 4 which is very good according to THIPON standards. FIGURE 8 shows a graph of the results of measuring the delay value.

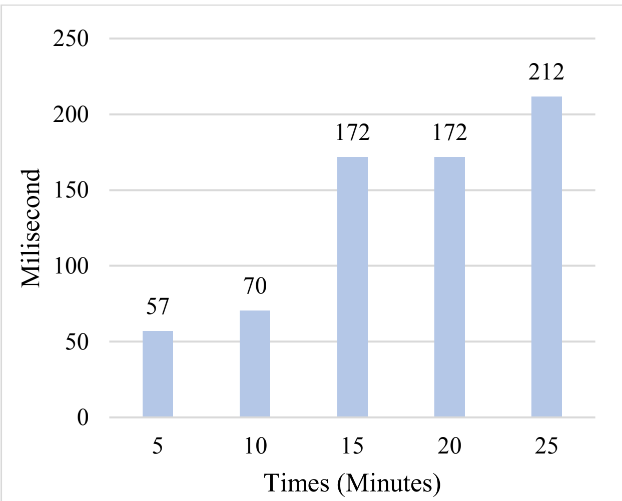

FIGURE 8. Graph of Delay Value Measurement Results

The average delay measurement value is 44.1 with an index value of 4 which is very good according to THIPON standards, a very good delay latency value of <150 msec.

4). JITTER

Testing the jitter value obtained an average jitter value of 21.28 msec, the results of measuring the jitter value can be categorized as good degradation with an index value of 3 according to the THIPON standard. From the results of jitter measurements using Wireshark, it was obtained that the jitter value in the 15-minute span was 32.81 msec, included in the category of good jitter values. The calculation value above uses the jitter value in the 10-minute timeframe, at an index value of 3 which is Good, because the vulnerable value of 8.2 msec according to the THIPON standard is a good value range of 0 to 75 msec when seen on the graph marked in green. The measurement time of the jitter value at 5 minutes is 10.8 and the jitter value at 25 minutes is 29.9. Data collection was taken at night in the Physics Laboratory of the Telkom Purwokerto Institute of Technology with the aim that the data obtained would get good results. FIGURE 9 show graph of the measurement results of the Jitter value

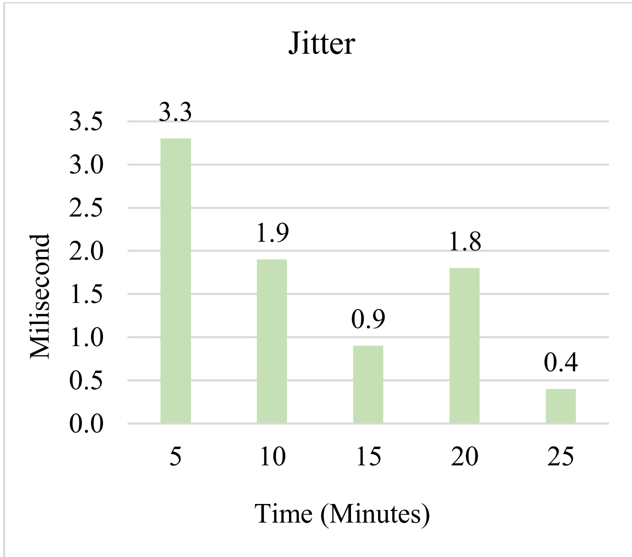

FIGURE 9. Graph of Jitter Value Measurement Results

IV. DISCUSSION

Quality measurement in the biomedical device is crucial concerning its functions and safety issues to the patients [16]. The biomedical device has been massively established with the immense objective to answer the health problem. One of the problems in the medical device is the confirmation when it is managed detection or measurement [17]. In the digital revolution era, biomedical instruments are established by integrating internet for monitoring patient[18][19]. In some cases, real-time monitoring is needed to make sure in patient's condition. This is the reason why ISO 17025 could be potential to be applied to validate measurement of medical tools. ISO 17025 could inform regarding the validation method, error value and measurement uncertainty[20]. This standardization has been applied for evaluating technical prerequisite in electrical safety laboratory for electromedical devices[21] and incubator radiant warmer analyzers[22]. Furthermore, a conventional method that is to be applied in internet's network is Quality of Services (QoS). QoS determines the combination of affected parameters regarding the service performance related to the level of satisfaction of a user [23]. These parameters consist of throughput, packet loss, delay, and jitter [23][15].

It could be highlighted that this study imposed to build medical box managed by IoT and could be perform as reminder regarding time to take the medicine. Based on the result it could be seen that the buzzer is successfully active, and the servo is working to provide the packet of medicine. This system also provides the information regarding temperature and humidity which are essential parameters to maintain medicine quality.

Due to investigate the quality of medical box, this study used two standardization which are ISO 17025 and QoS. ISO 17025 is standardization regarding quality measurement that could describe the ability and limitation of the tools. Furthermore, the QoS is standardization that usually used in networking investigation which is suitable for tools that used IoT platform.

The limitation of this works is regarding the integrated system with clinician. Another works, the system could be combined by involving the doctor[24]. Different approach in medical box development also established by connected with wearable device that could monitor the condition of the elderly[25][26]. Interesting approach also provided by using sensor to consider the elderly body[27]. Another medical box also could provide the weight of each medicine, inform the number of remaining pills, and generate alarms whenever the patient did not take the required number of medicine[28]. It is also improved by message alerts to predefined guardian if there are any vital signs noticed [29][30].

Comparing with the similar works which had been reported, it could be witnessed that this reported has advantages regarding the quality standard that make sure the ability of the function especially reminding and providing medicine is robust. In this report the consideration of ISO 17025 has been adapted to act as validation method incorporating selectivity, sensitivity, precision (repeatability), accuracy and bias, working range, and toughness (robustness and reproducibility). Moreover, it is combined with QoS to seek the functionality of medical tools to be implemented in the elderly. Hopefully, this report could be used as enrichment perspective increasing the quality of medical device development.

V. CONCLUSION

Based on the data from the test results and discussion regarding Medical Boxes for the Elderly with Alarm Notifications on Android Applications Along with Standardization of Quality Adapting Iso 17025 and QoS, it is concluded that Medical Boxes can be designed according to the system that has been designed, namely Infrared sensors, servo motors and DHT 22 sensors which are function for monitoring Medical box. Based on ISO 17025 measurement quality assurance testing, namely: (a) Sensitivity: The results obtained stated that the DHT 22 sensor used had good sensitivity accuracy for measuring temperature and humidity in medical boxes when compared to standard Hygrometer tools. (b) Selectivity: The servo motor can be selectivity for the time that is set for 7 repetitions in the same minute. (c) Accuracy: The trueness measurement accuracy value is 99.7% and the bias value is 0.318%, so the trueness and bias values obtained have a very good accuracy value. (d) Precision: Medical box precision by measuring the value of the difference in temperature and humidity with the acceptance limit data distribution with a value of 83%, a warning limit of 10% and data out of control of 6%. (e) Working range: testing the limit of detection (LoD) value by measuring the lowest time value at the time of testing. Equipment Toughness: The Medical Box System has been tested for tool toughness by operating the system for ±7 hours of research. Based on the quality of QoS testing using the THIPON standard, testing the QoS value on the network used by the system can be categorized as very good for Throughput, namely 92996.4 bps, packet loss of 0 %, delay value of 44.1 msec with a very good standard value because < 150 msec and the Jitter value obtained is 1.7 msec in the good category.

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DEWI SEKAR ARUM was born in Palembang, South Sumatra, Indonesia in 2000. Obtained a Bachelor of Engineering degree majoring in Telecommunications Engineering from the Telkom Institute of Technology Purwokerto, Indonesia, in 2022.
She had experienced in joining Huawei Investment Internship with Cloud Project Storage for Medical Box. She also studied regarding Quality Assurance in PT ICON plus and Radio Frequency in P.T. Sinergi Indonesia.

DANNY KURNIANTO was born in Banyumas, Central Java, Indonesia in 1982. He received the B. Eng degrees in electrical engineering from the University of Brawijaya, Malang, in 2007 and the Master of electronics information system degree in electrical engineering department from Universitas Gadjah Mada, Indonesia, in 2014.
From 2019 to 2022, he joined in Electronics and control research group in Institut Teknologi Telkom Purwokerto.. His research interests include signal processing and internet of things. He is an Editor-in-chief of Jurnal INFOTEL from 2014 to 2022.

MUHAMMAD YUSRO was born in Pemalang, Central Java, Indonesia in 1989. He received the B.Eng. degree in Nuclear Engineering in Physics Engineering Department from Universitas Gadjah Mada, Indonesia, in 2012 and he continued Master of Biotechnology degree with major in Biomedical Engineering also from Universitas Gadjah Mada, Indonesia, in 2014.
From 2012 to 2019, he joined a Research Team in Biomedical Engineering Research in Universitas Gadjah Mada. He is the head of Biomedical Engineering study program in Institut Teknologi Telkom Purwokerto, Indonesia since 2020. His research interests include Biofabrication, Biomaterial, Tissue Engineering and Standardization of Medical Device.