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Antenatal Care Bed For Preeclamsi Early Detection Based on Web System

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ABSTRACT One of the causes of the high maternal mortality rate is dominated by three factors, one of which is preeclampsia. Preeclampsia is a condition in which the mother experiences hypertension and changes in BMI (Body Mass Index) at the 20th week of gestation. Preeclampsia indications in pregnant women are related to examinations, namely Antenatal care (ANC). Antenatal care is one of the prenatal checks with certain standards. Pregnant women need extra antenatal supervision from health workers. Preeclampsia detection carried out in health care facilities is currently considered to be still not optimal so that there are still many cases of preeclampsia that are not handled properly. A web-based ANC test is one of the ways that services for pregnant women may be improved. To make NIBP and BMI data supplied and received by IoT media helpful for the diagnostic procedure, this study will evaluate them. Knowing the reaction of NIBP and BMI data provided and received over IoT medium is the contribution of this research. The MPX5050 sensor and Loadcell, whose output will be processed and presented on a web page, will be used in the technique to accomplish this purpose. Although the largest error value was -5.4 at the measurement point of 150 mmHg at diastole, it can be argued that the measurement findings for the NIBP parameter are plausible. Overall NIBP measures, however can be considered practicable and can be used to human measurements. Additionally, the weight parameter measurement data have an error value of 0.19328%. From this study, it can be inferred that transmitting IoT-based NIBP and BMI data has an impact on received lost data or delays. The findings from this study are expected to be developed in further research. So that it can be said that the use of the ESP32 module as the delivery of ANC BED inspection results resulted in no loss of data found in sending ANC inspection results with 100% data results being sent without any data loss and delay with an average of 2 seconds.

INDEX TERMS NIBP, BMI, MPX5050, Loadcell, WEB.

I. INTRODUCTION

The care given by medical professionals to all pregnant women as part of routine antenatal care (ANC) is described as ensuring the greatest possible health for mothers and their fetuses during pregnancy [1][2]. One of the causes of the high maternal mortality rate is dominated by three factors that affect pregnant women. Among these three factors are dominated by bleeding which reached 30.3%, hypertension in pregnancy 27.1%, to infection reached 7.3%[3][4]. Preeclampsia is a condition in which the mother experiences high blood pressure at the 20th week of pregnancy even though the pregnant woman has no history of high blood pressure or hypertension [5][6].

At the Kampung Harapan Health Center, Jayapura Regency, Herlando Sinaga performed study on Antenatal Care Examination (ANC) for Infectious Diseases in Pregnant Women in 2018 [7][8]. In this investigation, the authors continue to assess blood pressure manually using a tensimeter to determine if it is 120/90 mm Hg (normal) or 120/90 mm Hg (high)[9][10]. Dirman Nurlette did research on the creation of optimum height and weigpht measurement tools based on Arduino in 2018[11]. In this study, there were still deficiencies in the mechanical and casing parts. In 2014 Agustina, S.Kep. Ns., M.Kes conducted research on the Effectiveness of C-Reactive Protein Indicators as Early Detection of Preeclampsia in Pregnancy[12].

So with the phenomenon that occurs, so far the most common medical way to treat preeclampsia is through antenatal care examinations. Antenatal care is one of the prenatal checks with certain standards to prepare mothers for childbirth[13] [14]. Where pregnant women with a history of preeclampsia are very vulnerable and at risk of experiencing preeclampsia again in subsequent pregnancies. Preeclampsia detection carried out in health care facilities is currently considered to be still not optimal so that there are still many cases of preeclampsia that are not handled properly[15][16]. There are several factors that underlie this problem, including the large number of pregnant women patients every day, the limited number of health workers in each health service facility, to inaccuracies in examinations. Some of these factors then become the underlying causes of pregnant women with the condition of preeclampsia not being handled properly so that it can cause complications that can lead to death[17][18][19].

Based on the phenomenon above, the authors intend to provide an innovation in the world of health, especially to carry out early detection of preeclampsia in pregnant women. The innovation of the preeclampsia detection tool for pregnant women which is modified in the form of a mattress is considered capable of overcoming problems that occur during antenatal care[20][21]. This ANC bed is also equipped with a TFT LCD display that can assist medical staff in writing patient health data and several other features including the preeclampsia detection parameter which is able to automatically access history of examination data of patients who come to check pregnancy conditions via the WEB[22][23][24]. Equipped with delivery of NIBP and Weight results with the WEB system which can help medical personnel to monitor the results of examinations of pregnant women.

II. MATERIALS AND METHODS

A. EXPERIMENTAL SETUP

This study uses a fluke digital pressure meter (DPM) to measure the MPX5050GP sensor which will be used for NIBP parameters[25][26]. And using a calibrated scale with the Kris brand as a comparison tool for body weight parameters. Apart from that, there is also a web that has been hosted to conduct research on data loss and delay. With humans aged 20-30 years.

1) MATERIALS AND TOOL

This study used the MPX5050GP sensor for NIBP measurements in addition to loadell and HX711 for body weight measurements[27]. Programmed via the Arduino Mega microcontroller and sent to the web via ESP32.

2) EXPERIMENT

At the time of measurement the patient went up to the bed to take NIBP measurements and also body weight. When taking measurements the user registers the patient's ID first. Then enter the results of the height measurement after that take measurements in each parameter, namely NIBP and also body weight. After measuring the results obtained by the microcontroller, they will be sent to the web via ESP32. The data sent includes patient ID, height, systole, diastole, and weight, and BMI. Furthermore, the analysis is carried out on delay and data loss when data transmission takes place.

B. THE DIAGRAM BLOCK

In FIGURE 1 show the block diagram. The block diagram above has 3 main parts, namely input, process and output. The input consists of a Loadcell sensor which will later produce a resistance value and be read by the HX711 module which will produce weight data. After that there is a cuff that functions to put pressure on the patient's arm and is read by the MPX5050GP pressure sensor. In the process section there is an Arduino Mega microcontroller which functions as a data processor from the sensor output. At the output there is a motor driver control and a solenoid valve, besides that the measurement results appear on the TFT LCD, and the ESP32 functions as a serial communication with the Arduino Mega which later the measurement results can be sent via the WEB.

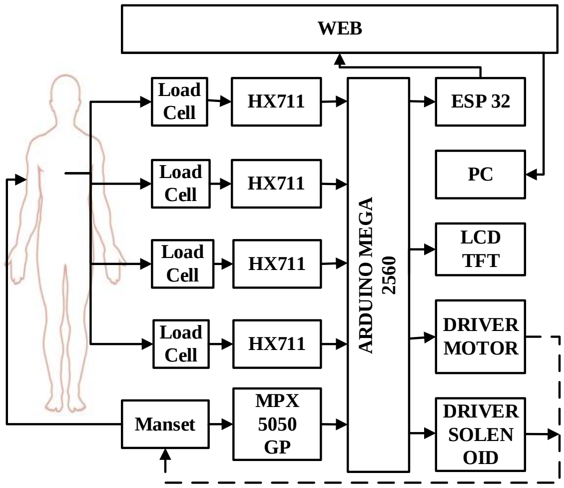

FIGURE 1 Block diagram of Bed Antenatalcare. The output of sensor of pressure MPX5050gp is an analog, then will be process on the Arduino mega. And the HX711 module its for detect weight value

C. THE FLOWCHART

1) DEVICE FLOW CHART

In FIGURE 2 turn Activate the ON button, once the module is activated, the process starts with initialization, once completed, it will go to the stage of reading the preliminary input from the Loadcell sensor, then it will do the transfer. convert the resistor value to the ADC value on the HX711 module, paving the way for an uninterrupted weight assessment process. Then in the secondary input reading stage, specifically originating from the MPX5050GP pressure sensor, which then proceeds seamlessly in translating the ADC value into millimeters of mercury (mmHg), thus achieving the corresponding values for systolic and diastolic. measure. The data set, encapsulating NIBP measurements and weight values, will be clearly displayed on the TFT LCD. Therefore, in the event that Wi-Fi is not connected, the operation cycle will switch to displaying data on the TFT LCD screen. Conversely, if the device is securely connected to a Wi-Fi network, the ESP32 microcontroller must send NIBP and BMI data to the specified WEB platform, which is quickly activated by pressing the built-in transmit button. in the module interface. The data transmission will be done using the Post method. After this transfer, the resulting measurement results are clearly displayed on the web interface, quickly browsing through the database archive as a persistent historical record. Thus, at the end of the sequence, the whole system reaches the completed state. .

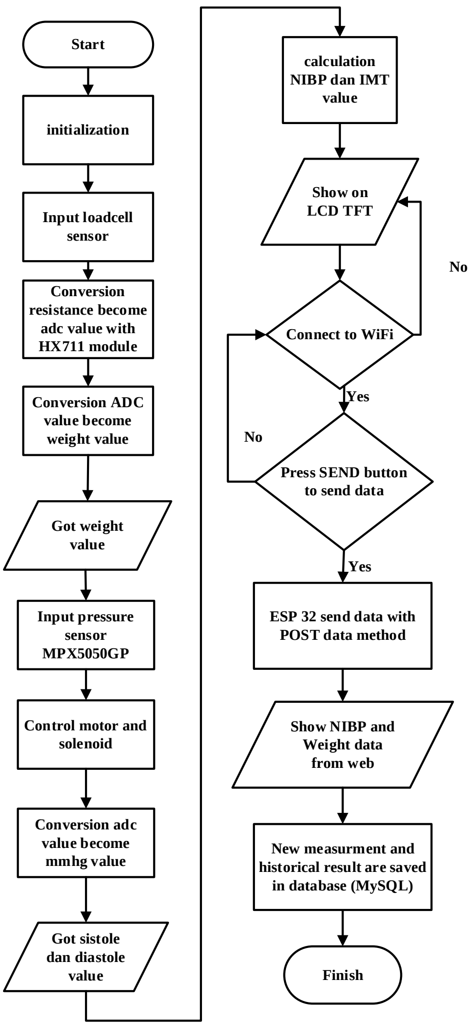

FIGURE 2. **The flowchart, the NIBP and Weight reading is then processed by Arduino which is then displayed on the nextion and send to website.**

2) WEBSITE FLOW

in FIGURE 3 chart The use of the chart in site mode is dependent on the availability of an active internet connection at the specific measurement site. After successful detection and collection of NIBP measurements and BMI calculations, the module transitions seamlessly to the dedicated web interface. In this specified web domain, the initial prerequisite is related to user authentication, which requires a secure login process.

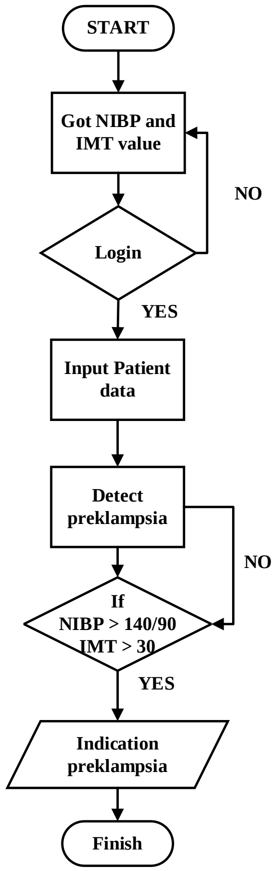

FIGURE 3. **The flowchart, get the value of NIBP and BMI to detect precalmsia.**

It is then imperative to digitally include comprehensive patient data, thereby establishing a solid foundation for further analysis. The dynamic web platform skillfully depicts the obtained measurement results meticulously, providing a comprehensive visual representation of the obtained data. This illustrative representation effectively summarizes the nuanced results obtained from the calculated NIBP and BMI measurements. As a major improvement, the website interface is already equipped with a built-in algorithm designed to distinguish the presence of a significant medical condition – preeclampsia. Under this intelligent algorithm, the website scrutinizes the resulting measurement results, putting them in a rigorous comparison with predefined thresholds. In case the measurement result exceeds the specified value, namely, the NIBP criterion is > 140/90 and the BMI exceeds the threshold > 30, there will be a decisive signal. This revealing result clearly indicates the potential presence of preeclampsia in the patient. The culmination of this complex process represents an important step towards improving patient care and medical diagnosis through a seamless combination of advanced sensor technology, intelligent algorithms and communication. web interface.

D. SYSTEM CIRCUIT

The HX711 loadcell module and MPX5050GP circuit shown in FIGURE 4 were crucial to this development. The weight reader and NIBP both use this circuit. Thus, it will be prepared for digital processing using an Arduino Mega.

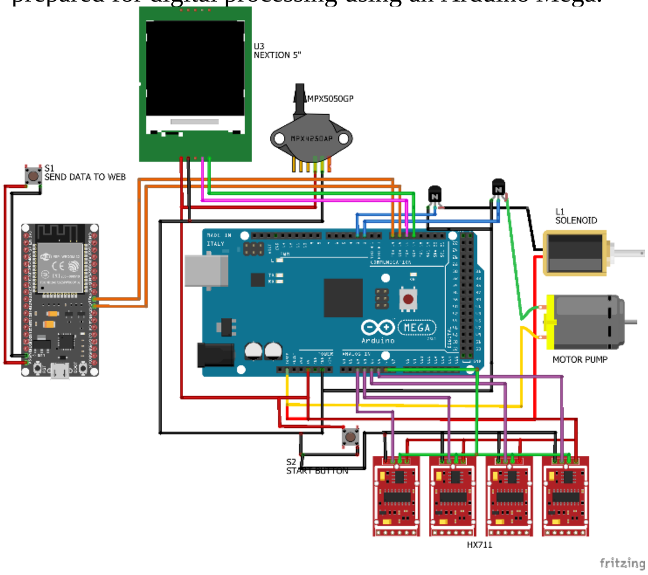

FIGURE 4. Bed ANC system circuit for operating device Bed ANC for Preecalmsi

III. RESULT

In this research, the design has been put to the test on a NIBP calibrator using Fluke PROSIM device.

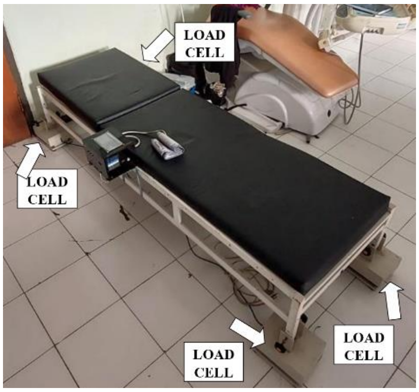

FIGURE 5. Design of BED ANC to measurement NIBP and weight the patient

FIGURE 5 is the result of the antenatal care bed assembly which will later be used to measure NIBP and the patient's weight to determine the early detection of preclampsia in patients

FIGURE 6. The design of circuit to process the measurement NIBP and Weight

FIGURE 6 Is The circuit design photo above consists of the Arduino Mega microcontroller as NIBP control, body weight, receiving data from nextion, and serial communication with ESP32. Furthermore, there is an ESP32 module for sending data to the WEB.

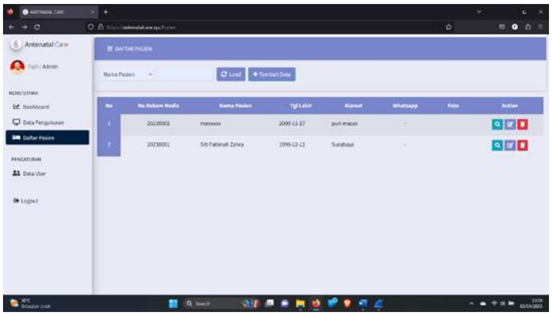

FIGURE 7. The design of web for monitoring and data saved to database

FIGURE 7 is a web that is used to receive data on the results of NIBP measurements and patient weight. on the web also stores measurement data in the database.

In addition there are MPX5050GP sensors, Motor Pump, solenoids, and a series of motor drivers and solenoids for NIBP parameters. The HX711 module is under the bed. And for the power itself using an external adapter of 12v.

After the device is ON, the initial display on the display is Homepage. When the Homepage is pressed, it will enter the page containing the patient id which must fill in the 8-digit patient id to provide each patient id. Next, enter the page with the contents of the height, the same as the contents of the patient id. It is necessary to input height data according to the height measurement manually. Next, the initialization of the MPX5050GP pressure sensor program is initialized at pin 0. In addition, there is also a conversion from adc to mmhg values. MPX5050GP is a pressure sensor that uses piezoresistive technology. This sensor can detect air or gas pressure and convert it into an electrical signal that can be read by a microcontroller or other electronic system. Furthermore, Arduino is used as a motor pump control and solenoid. and the MPX5050GP sensor as a pressure sensor, functions to detect blood pressure obtained from the pulse of the arm, when the arm is given air pressure by the cuff. The ANC bed device uses 4 loadcells and also uses 4 HX711s to convert analog to digital values and send them to Arduino Mega. The program also reads the results of weight measurements and takes the average value for each loadcell. there is a nextion program used to initialize each button on nextion. Besides that, there is read data from nextion. Apart from the read program from nextion, this tool also has a write program to show the results of weight measurements and also NIBP. Furthermore, the results of NIBP and weight measurements as well as patient ID data and patient height are sent using serial communication from Arduino to provide data to ESP32 if there is a request from ESP32 then from ESP32 sends measurement results via the web.

In During the measurement evaluation, the ANC Bed Tool assesses two vital parameters: Non-Invasive Blood Pressure (NIBP) and body weight. Notably, the comprehensive assessment of NIBP measurements indicates their viability and suitability for human use. To further enhance the precision and effectiveness of the study, the measurement outcomes are meticulously juxtaposed against digital scales that have undergone rigorous tracing. It is noteworthy that these digital scales boast a precision of up to two decimal places, thereby elevating the accuracy and optimality of the weight measurement values. By expanding upon this section, it underscores the dual-parameter nature of the measurement process, accentuates the practical applicability of NIBP measurements, and underscores the efforts taken to ensure accurate and refined weight measurements through comparison with highly precise digital scales. This expansion reinforces the robustness of the study's methodology and the meticulousness in achieving reliable measurement outcomes.

TABLE 1
NIBP measurement results in humans to detect mean every point

Respondent	NIBP	Mean mmHg	±SD
A	Sistole	108.4	16.19383
	Diastole	86	11.20714
B	Sistole	102.2	9.453042
	Diastole	67.6	17.48828
C	Sistole	125	14.73771
	Diastole	76.4	19.42782
D	Sistole	102.6	19.30389
	Diastole	78.4	12.1095
E	Sistole	115.8	7.304793
	Diastole	78	9.143304
F	Sistole	120.6	7.116179
	Diastole	72.4	6.651316
G	Sistole	122.8	10.06777
	Diastole	69.8	3.1241

TABLE 1 explains that there are results of the In the of NIBP measurements in humans, which are in TABLE 1, the results are as above. These results were obtained by performing 5 measurements in humans.

TABLE 2
The results of measuring body weight with scales and measurement with a bed tool

Subjects	Weight measurement with calibrated scales (Kg)	Measurement with a bed tool (Kg)	Error (%)	Mean error (%)	± SD
A	69.15	69.33	0.2603	0.193	0.142
D	50.24	50.23	0.0199		
I	75.22	75.45	0.3058		
P	62.41	62.36	0.08012		
O	63.62	63.42	0.31437		
S	62.64	62.56	0.12771		
F	63.33	63.23	0.1579		
W	55.72	55.41	0.5563		
C	45.31	45.26	0.11035		
D	47.25	47.25	0		

TABLE 2 explains The results for the parameters used to measure body weight in this study are in good agreement with the findings described in TABLE 2. This particular review offers similarity between the measurement of body weight. human body using an innovative and meticulously calibrated method to measure individuals while lying on a bed. This empirical discovery follows a trajectory in which measurements were obtained from a group consisting of ten different individuals, each with a distinct body weight. These experimentally derived measurements were then meticulously compared with recorded body weight measurements obtained through the bed-based assessment method.

In Within the extensive array of measurement results laid out earlier, a singularly remarkable observation commands attention – specifically, the noteworthy recording of the highest human weight at a striking 75.22 kg. Through the amalgamation of empirical examination, the device's meticulous measurements replicate this phenomenon with astonishing precision, echoing at an impressive 75.45 kg. This consistent alignment underscores the instrument's robustness and precision, showcasing its capacity to capture and faithfully replicate the intricate subtleties inherent in the spectrum of human weight variations, which span a diverse range.

By expanding upon this section, we further emphasize the exceptional nature of the observed phenomenon, elaborate on the accuracy of the device's measurements, and underscore the broader implications of this alignment on the instrument's reliability and effectiveness in capturing the complexities of human weight dynamics..

Essentially, this empirical exploration navigates the field of body weight measurement with utmost diligence, meticulously comparing readings on traditional calibrated scales with advanced in-bed measurements. . The outstanding concordance between the highest recorded human weight and the corresponding instrumental measurement not only confirms the strength of the device, but also enhances the knowledge of bright body weight assessment methods create and correct. As the experimental journey draws to a close, it beckons towards a horizon brimming with possibilities, inviting further exploration and refinement in the science of measurement.

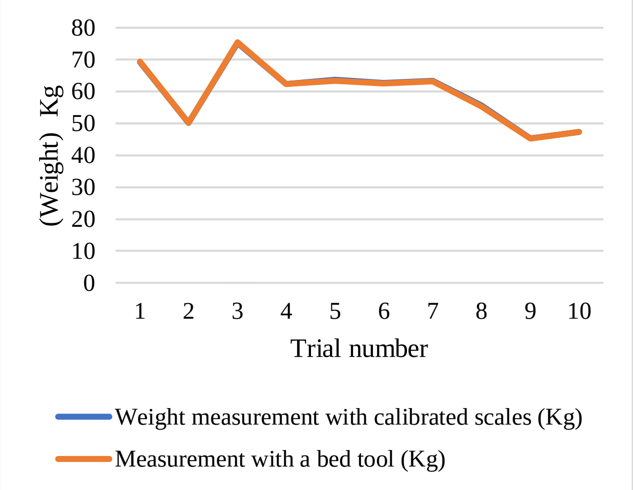

FIGURE 8. Graph of weight measurement results with scales and measurements with a bed device

FIGURE 8 showcases the weight parameter, revealing an average error result of 0.000800634%. The data presented in FIGURE 8 pertains to the measurement outcomes of body weight, as depicted provide a visual representation such as a graph or table illustrating the body weight measurement results. By expanding upon this section, we delve into the implications of the weight parameter assessment, provide a visual representation of the gathered data, and underscore the significance of the outcomes depicted in FIGURE 8 within the context of the study.

TABLE 3
Calculation of the results of observations of Latency (Delay)

No	Respondent	Mean	± SD
1	Hfz	2	1.154701
2	Arn		
3	Dzh		
4	Kkh		
5	Frr		
6	Wld		

TABLE 3 The results of the latency (delay) detection use the ratio of units of seconds to hours. And use the average (average) formula shown in TABLE 3. The delay calculation results above use the formula Eq. (1) :

$$Delay = receiving\ time - sending\ time \quad (1)$$

With the Based on the aforementioned distribution results, it is clear that the average delay is 2 seconds. In particular, the most significant delay occurs in measurement number 8, which imposes a consecutive delay of 5 seconds. In contrast, measure number 18 emphasizes minimal latency, giving immediate results of 0 seconds. Collectively, these results strongly imply that the time requirement for test data transmission remains undeniably sufficient.

TABLE 4
The results of receive packet data to website

Date	Subjects	Weight	Height	Systole (mmHg)	Diastole (mmHg)	BMI
03/04/2023 05:22	A	55.20 Kg	1.63 cm	116	85	20.78 Kg/m²
03/04/2023 05:24	A	55.20 Kg	1.63 cm	116	85	20.78 Kg/m²
03/04/2023 05:28	A	54.95 Kg	1.63 cm	108	87	20.68 Kg/m²
03/04/2023 06:39	B	59.52 Kg	1.68 cm	129	87	21.09 Kg/m²
03/04/2023 06:40	B	59.52 Kg	1.68 cm	129	87	21.09 Kg/m²
03/04/2023 06:43	B	59.62 Kg	1.68 cm	106	73	21.12 Kg/m²
03/04/2023 06:57	C	50.92 Kg	1.64 cm	154	58	18.93 Kg/m²
03/04/2023 06:58	C	50.92 Kg	1.64 cm	154	58	18.93 Kg/m²
03/04/2023 07:05	C	51.23 Kg	1.64 cm	112	82	19.05 Kg/m²
03/04/2023 07:35	D	83.10 Kg	1.76 cm	142	106	26.83 Kg/m²
03/04/2023 07:42	D	82.78 Kg	1.76 cm	167	109	26.72 Kg/m²
03/04/2023 07:43	D	82.78 Kg	1.76 cm	167	109	26.72 Kg/m²
04/04/2023 10:46	E	47.63 Kg	1.65 cm	96	79	17.49 Kg/m²
04/04/2023 10:46	E	47.63 Kg	1.65 cm	96	79	17.49 Kg/m²
04/04/2023 10:49	E	48.06 Kg	1.65 cm	111	104	17.65 Kg/m²
04/04/2023 10:59	F	66.92 Kg	1.65 cm	106	93	24.58 Kg/m²
04/04/2023 10:59	F	66.92 Kg	1.65 cm	106	93	24.58 Kg/m²
04/04/2023 11:00	F	67.13 Kg	1.65 cm	111	91	24.66 Kg/m²

To measure packet loss, which is to calculate the data sent and data received with the formula Eq. (2):

$$loss\ data = \frac{((data\ send - data\ receive))}{(data\ send)} x\ 100\% \quad (2)$$

$$loss\ data = \frac{18 - 18}{18} x\ 100\%$$

$$data\ loss = 0\%$$

With this it can be said that the measurement data sent from ESP32 is 100% all sent via the web with the result of 0% data loss.

IV. DISCUSSION

Extensive analysis was performed to evaluate the latency and potential for data loss when transmitting Bed ANC measurement results through the web-based ESP32 module. The results of this test are described as follows. Therefore, it can be inferred that using the ESP32 module to transmit ANC test results results in no data loss during measurement results transmission. Data was transferred efficiently without any data loss, and the average latency recorded was around 2 seconds.

Unlike previous investigations involving weight measurement parameters that encountered deficiencies in their envelopes, this particular study was meticulously designed with the goal of designing a more efficient envelope. Designed for measurement purposes. The researchers cleverly designed an envelope under the bed. Compared to a 2022 study conducted by Dita Ayu Chairunnisa, this study focuses on the IOT based weight scale and calorie tracking application [27], and in which the HX711 module is used. from the results of measuring the body weight of the antenatal care bed, the average result was 0.193275%. The results of this measurement are somewhat better than measurements in previous studies, namely the average result is 1.68%. Addressing the transmission aspect, in a this study, the packet loss data measurement parameter resulted in no data loss or 0%. In the previously mentioned research effort from 2022, conducted by Audia Yumna Dita Pramesti, focusing on Monitoring Android Application [22], ESP32 was operate as an integral part of an actual system. Time monitoring system, powered by the Google Maps platform that acts as a cloud vehicle. The packet loss setting gives an average rating of 0.4%. In the previously mentioned research effort from 2022, conducted by Filantropi Yusuf Aji Cahyono, focusing on Home Security System based on an ESP32 Cam Microcontroller with Telegram Notification [24], in this study there are deficiencies with previous studies, namely the delivery delay. In this delivery delay, a value of 2 seconds is obtained. when compared with previous studies, namely getting a delay of 0.05974 seconds.

However, this tool still contains some vulnerabilities. It requires the presence of a laptop to monitor and authenticate the successful transmission of measurement data over the web. In addition, the NIBP sensor, designated MPX5050GP, has been reported to exhibit suboptimal performance when it comes to ensuring accurate NIBP measurements. In addition, excessive use of the HX711 module for weight measurement is considered unnecessary. A more sensible approach would involve using the HX711 module alone for weight measurement.

A key advantage inherent in this research tool is that the measurement of NIBP and BMI parameters is no longer dependent on manual recording during testing, thus improving measurement accuracy. Automated transmission and web-based storage of measurement results for easy tracking of historical data. Patients have the ability to access their historical data through the dedicated antenatalcare.xyz website.

V. CONCLUSION

It the objective of this study was to analyze NIBP and BMI data transmitted and received via IoT media, thereby contributing to the diagnostic process. The contribution of this study lies in understanding the response of NIBP and BMI data transmitted and received via IoT media. The process to achieve this goal involves the use of MPX5050 and force sensors, the output of which will be processed and displayed on site.

Overall performance of this device uses a variety of components and modules, including a 5-inch Nextion TFT display, an Arduino Mega and an MPX5050GP sensor, which operates on DC 5V for NIBP installations. MPX5050GP sensor and HX711 module were used, connected to Arduino Mega and then initialized. After initialization, the measurement begins. Measurement results including NIBP, weight, patient ID and patient height are transmitted via serial communication from Arduino to ESP32. The measurement results are then sent to the web via the ESP32. Patient data on the web can be downloaded in Excel or PDF format and accessed via antenatalcare.xyz. The overall NIBP measurement results in an average error of 2.8568% and can be used to measure in humans. In addition, the measurement results for the weight parameter have an error value of 0.19328%. Data transmission over the web uses the POST data method, resulting in a 2 second delay with no data loss.

Further developments in this study can be made on different aspects. For further studies, a green indicator should be embedded on the Nextion display to signal that the data has been successfully transmitted over the web. This eliminates the need to monitor via a laptop to check if a data transfer has taken place. An improved pressure sensor is recommended to improve the stability and calibration of the measurement. In addition, using a single HX711 module for weight measurement improves efficiency.

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