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Design and Development of a Digital Baby Height and Weight Measuring Device Based on the Internet of Things at Posyandu Alamanda

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Abstract

Posyandu is a basic health service that plays an important role in integrating the growth and development of infants and toddlers. However, the manual data recording process is still widely carried out, which is prone to errors and delays in recording. This study aims to design and build a baby weight and height measuring system based on ESP32 with integrated sensors and RFID cards, which can automate data recording to Google Spreadsheet in real-time. This system uses a load cell sensor for weight measurement and an ultrasonic sensor for height, as well as an RFID RC522 module for identifying the baby's identity via an RFID card. The measurement data is displayed on a 16x2 I2C LCD screen and is automatically sent to a spreadsheet after the RFID card is attached. The system development method used is Rapid Application Development (RAD), with stages of needs planning, system design, development, and implementation. The test results show that the system can measure and record data with good accuracy and make it easier for Posyandu officers in the data collection process. This system is expected to be a practical and efficient solution in supporting the digitalization of basic health services at the community level.

Keywords: *ESP32, Google Spreadsheet, Height, loadcell, Rapid Application Development (RAD).*

1. Introduction

The infancy period is considered a golden stage of child growth and development, during which their health requires special attention. Adequate nutrition, routine health monitoring, and early prevention of health issues are key factors in ensuring optimal growth. In this stage, regular monitoring is essential, where parents are advised to bring their babies to the local health post (posyandu) once a month for growth and development checks. Posyandu Alamanda, located in Sukamaju, Cilodong, Depok, serves as one of these community health posts, offering services such as weight and height measurements, vitamin distribution, and immunizations to support child health and prevent issues such as malnutrition[1].

However, during health service activities at Posyandu Alamanda, long queues often occur due to the large number of participants waiting to measure their babies' weight using traditional scales. After weighing, data recording into the child's health card (Kartu Menuju Sehat/KMS) further slows down the process, leading to inefficiencies in administration [2]. These issues reduce service effectiveness and quality, potentially causing inconvenience for parents and affecting satisfaction with the health services provided [3].

To address these challenges, this research proposes the development of a digital baby height and weight measuring device integrated with an Internet of Things (IoT)-based data management system. The device features a digital scale that displays weight measurements in real time on a 16x2 I2C LCD screen [4]. Each baby is provided with an RFID card containing personal data such as neighborhood number (RT), name, previous weight, and height. By scanning the RFID card after weighing, the latest health data is automatically saved in the system and directly uploaded to Google Spreadsheet. This eliminates manual recording, making data collection faster, more accurate, and better organized while also reducing the risk of errors and long queues [5].

In addition, the system is supported by a Kodular-based mobile application that integrates with Google Spreadsheet. This allows health workers and parents to easily access baby health data digitally [6]. Parents can view their child's weight and height records without having to visit the posyandu, while health workers can filter data based on neighborhood areas (RT 1 to RT 5). With this digital solution, Posyandu Alamanda is expected to modernize its services, improve efficiency and accuracy in health monitoring, and enhance the overall quality of healthcare for infants and toddlers in the community [7].

2. Research Methodology

2.1. Rapid Application Development (RAD)

The development model used in this research is the Rapid Application Development (RAD) model. Its main advantage lies in accelerating the development process, as user feedback can be obtained quickly and any necessary changes can be implemented accurately based on that feedback [8]. The RAD system development approach is illustrated in the figure below.

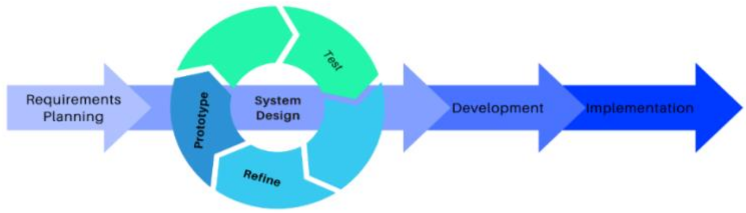

Fig. 1: Rapid Application Deveopment (RAD)

This research uses the Rapid Application Development (RAD) model which consists of:

1. Requirements Planning:
   Identification of system requirements based on interviews, consisting of:
   Identifying problems such as long queues and inefficient manual recording. Hardware needs include ESP32, load cell with HX711, ultrasonic sensor, RFID, LCD, and jumper cables. Software needs include Arduino IDE, Google Spreadsheet, and Kodular.
2. System Design:
   Designing hardware and software components, coding sensor integration, RFID, and data transfer to Google Spreadsheet. Prototyping, testing sensor accuracy, and refining the Kodular application.
3. Development:
   Assembling electronic components and programming the ESP32 microcontroller to ensure proper communication with Google Spreadsheet and the Kodular application.
4. Implementation:
   Deploying the system at Posyandu Alamanda to improve efficiency and accuracy in baby health monitoring and data recording.

3. Result and Discussion

The system is built on an ESP32 microcontroller connected to sensors [9], including a load cell for weight measurement and an HC-SR04 ultrasonic sensor for height measurement. Each baby is identified using an RFID card, allowing automatic matching of identity data. Measurement results are transmitted in real time via Wi-Fi to Google Spreadsheet for data storage, while also being displayed temporarily on a 16x2 I2C LCD [10]. Furthermore, the system is integrated with a Kodular-based application, enabling health workers and parents to easily access baby growth information directly from their smartphones.

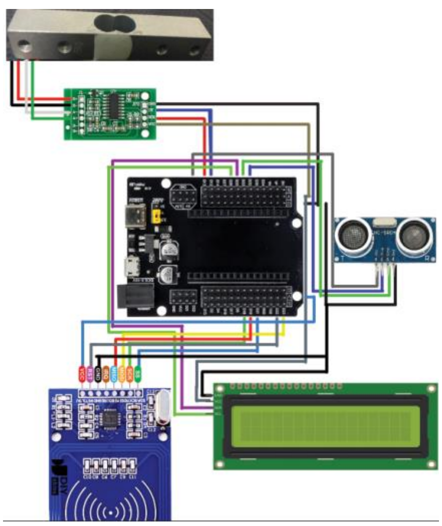

Fig. 2: Overall System Design

3.1. Main Components

The following are the main components of the digital baby height and weight measuring device based on the Internet of Things at Posyandu Alamanda:
1. ESP32: The main microcontroller used to control the system and send measurement data via Wi-Fi.
2. ESP32 Shield: An additional module that expands pin connectivity and enhances ESP32 stability.
3. Loadcell Sensor: Used to measure the baby's weight.
4. HX711 Module: Converts the analog signal from the load cell into digital data readable by the ESP32.
5. Ultrasonic Sensor (HC-SR04): Used to measure the baby's height.
6. LCD 16x2 I2C: Displays the baby's measurement data temporarily after weighing.
7. RFID Module: Identifies each baby by scanning their RFID card.
8. RFID Card: Contains the baby's identity data, making the process faster and eliminating manual input.
9. Google Spreadsheet: Functions as cloud-based storage to save and organize measurement data.
10. Kodular Application: A mobile application that allows health workers and parents to view baby growth data in real time.

3.2. System Flow

The block diagram below illustrates the workflow of the digital baby measuring device based on IoT [11]. The system involves the load cell sensor, HC-SR04 sensor, RFID, ESP32, LCD 16x2 I2C, and integration with Google Spreadsheet and the Kodular application. The inputs from the load cell sensor and the HC-SR04 sensor are processed by the ESP32 microcontroller, and the results are displayed on the LCD 16x2 I2C as information on the baby's weight and height [12]. The system is powered by an external power source, while programming and data processing are carried out using the Arduino IDE platform.

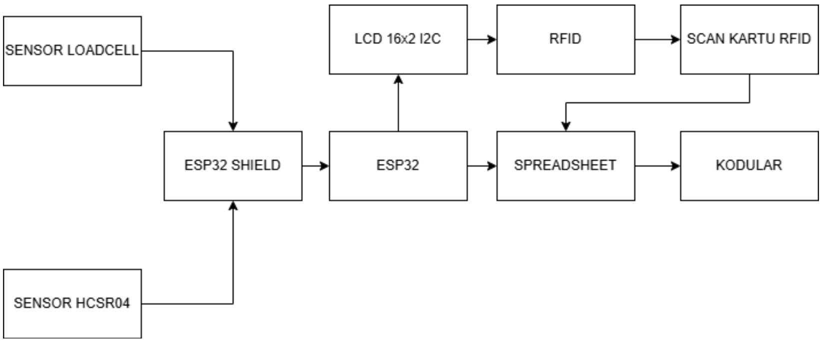

Fig 3: System Flow

3.3. Hardware Implementation Results

The ESP32 functions as the main microcontroller that controls the entire system. It receives data from the load cell (weight sensor) and the HC-SR04 ultrasonic sensor (height sensor), reads the UID from the RFID module, sends measurement data to Google Spreadsheet via Wi-Fi, and displays the results on the LCD 16x2 I2C. The ESP32 Shield is used to expand pin connectivity and ensure stable connections among components, making the system more organized and reliable. The load cell measures the baby's weight and is connected to the HX711 module, which amplifies and converts the analog signal into digital data for the ESP32 [13]. Meanwhile, the HC-SR04 ultrasonic sensor measures the baby's height by transmitting ultrasonic waves and calculating the reflection time to determine distance.

Fig 4: Hardware Implementation

The RFID module reads the unique ID from each baby's RFID card, enabling automatic association of measurement results with stored identity data in Google Spreadsheet. The LCD 16x2 I2C displays weight and height values in real time for health workers before the data is stored in the cloud. Each RFID card serves as the baby's digital identity, simplifying the data recording process. Overall, the integration of ESP32, load cell with HX711, ultrasonic sensor, RFID, LCD, Google Spreadsheet, and RFID cards results in a stable IoT-based system that efficiently measures and records baby health data.

3.4. Software Implementation Results

The front page functions as the welcome screen before users access the main features of the application. Once the “Start” button is clicked, the user is directed to the main page. On the measurement data page, a label is used to display the title, while a vertical arrangement organizes the content in a structured manner. A button allows users to load or update data from Google Spreadsheet, which is then displayed in a table format using the TableView extension [14]. Additionally, a notifier provides messages and loading alerts when retrieving data, and a Web component is used to call the spreadsheet URL.

Fig 5: Software Implementation

3.5. Measurement Time Difference: IoT vs. Conventional Method

Based on the results of the process time testing shown in the table, a significant difference was found between the measurement process time using the IoT-based device and the process without IoT [15]. The use of the IoT device, which is integrated with a load cell sensor, an HC-SR04 sensor, and RFID for baby identification scanning, demonstrated high time efficiency, with an average process time of 54.5 seconds. In contrast, the conventional process without IoT—which involves manually recording identity, measuring body weight and height, and noting the results in the KMS—requires an average of 158 seconds. Therefore, the implementation of the IoT device for measuring baby height and weight is able to reduce the process time by more than 65% compared to non-IoT methods.

Table 1: IoT Weighing Process Time

No	Time		
	Weight + Height	*RFID Scan*	Total
1	45 seconds	12 seconds	57 seconds
2	41 seconds	10 seconds	51 seconds
3	55 seconds	8 seconds	63 seconds
4	38 seconds	9 seconds	47 seconds
5	42 seconds	12 seconds	54 seconds
Average			54.4 seconds

Table 2: Conventional Method Weighing Process Time

No	Time				
	Identity	Weight	Height	KMS Recording	Total
1	10 seconds	52 seconds	33 seconds	66 seconds	161 seconds
2	8 seconds	55 seconds	37 seconds	61 seconds	161 seconds
3	11 seconds	49 seconds	36 seconds	56 seconds	152 seconds
4	8 seconds	57 seconds	41 seconds	58 seconds	164 seconds
5	10 seconds	51 seconds	32 seconds	59 seconds	152 seconds
Average					158 seconds

4. Conclusion

The test results show a significant difference between the processing time with and without the IoT-based device. The use of an IoT device integrated with a load cell sensor, HCSR04 sensor, and RFID requires only an average of 54.5 seconds. In contrast, the conventional method takes 158 seconds, meaning the IoT implementation is able to reduce processing time by more than 65% compared to traditional methods. Furthermore, by utilizing Google Spreadsheet as the storage medium for measurement results and RFID cards as baby identities, record-keeping in the KMS system can be optimized, thereby preventing data congestion.

For future research, it is recommended to increase the number of load cell sensors to support measurement stability. Additionally, improvements can be made to the Kodular application by adding a search feature for easier data access and a PDF export feature for generating reports.

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