Developing Electronic-Based Maternal and Child Health Monitoring

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ABSTRACT

Background: The first 1,000 days of life, encompassing fetal development during pregnancy (approximately 270 days) through the child's second year (approximately 730 days), represent a critical window for the development of vital organs, as well as cognitive and motor functions. Optimal monitoring during this period is essential for ensuring healthy growth and development. This study aimed to develop an electronic-based monitoring tool for maternal and child health, designed to deliver comprehensive, accurate, and timely information to facilitate early detection of health risks and support evidence-based interventions.

Subjects and Method: The study was conducted using the Rapid Application Development (RAD) approach, which includes the stages of planning, design workshops, and implementation. The tool is intended to be used by health cadres at integrated health posts (posyandu) to support maternal and child health monitoring.

Results: A simple and user-friendly electronic-based program has been developed to record and monitor maternal and child health status over time. Users can input the results of maternal and child health assessments, which are then presented in graphical form and can be printed as needed. The application received a feasibility score of 89.8% based on the PIECES framework, indicating strong potential for practical implementation.

Conclusion: Graphical representations in maternal and child health applications allow for easier monitoring of examination results. These visual tools enable early identification of potential malnutrition-related risks, such as stunted growth in children, thereby supporting timely intervention and prevention efforts.

Keywords: electronic-based program, pregnant woman, maternal and child health

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BACKGROUND

In the era of the Covid-19 pandemic, all countries established physical distancing. Various countries have decided to lock down (Muhyiddin, 2020). Many governments and private offices/ agencies implement the

Work from Home (WFH) (Mungkasa, 2020). The Government even recommends the public not visit hospitals during the Covid-19 pandemic except in emergencies, including for pregnant women and children. They are a group at risk of easily contracting infections (DeJong et al., 2010; Wihastyoko et al., 2021).

The nutritional adequacy of pregnant women and children must be balanced (Hanum, 2018; Sari et al., 2021). Body weight and height will affect Body Mass Index (BMI) and muscle strength (Susihono and Adiatmika, 2021). BMI can determine the category of thin, ideal, or obese body weight (Larwin and Woods, 2021). Body weight needs to be controlled to prevent the risk of health problems as well as screening for metabolic diseases (Astuti and Jenie, 2020). Mothers with postpartum depression have a negative impact on themselves and their babies (Rahmadhani et al., 2022).

Malnutrition in pregnant women and children can lead to stunting (Nurfatimah et al., 2021). Mothers' knowledge and economic ability are the triggers for stunting (Verma and Prasad, 2021; Moniaga et al., 2019). Stunting is a state of malnutrition that can inhibit brain, motor, and mental development and growth failure (Tuah, 2015). This increases the risk of maternal and child morbidity and mortality (Rahmadhani, 2021). Mother's knowledge affects children's anthropometry (Nguyen et al., 2022). The software has been developed to monitor the nutrition of pregnant women (Widodo and Farida, 2018) to prevent stunting. However, it is not enough if monitoring is only carried out on pregnant women, but also monitoring the adequacy of nutrition in children. This is useful for detecting the dangers of abnormal growth and development of the child's body.

Pregnant women should routinely check their pregnancy. The standard number of pregnancy checks is at least 6 times, after the postpartum period she has to check 4 times (Sugiyarti et al., 2016). Every time a pregnant woman comes for a check-up, she must bring a handbook, which is Kesehatan Ibu dan Anak (KIA) book. The handbook contains a history of examinations of pregnant women, and charts for monitoring the growth and development of children. However, pregnant women who do not comply with carrying the book have an impact on incomplete medical record data for pregnant women and are not sustainable (Kurniadi and Pratiwi, 2017). The midwife records the history of the patient's examination in the registration book by hand. If the book is full, the midwife will replace a new book. When patients come to visit again, it is difficult for midwives to trace the history of previous examinations (Wong and Bradley, 2009).

The study team is working to create an application that will make it easier to record patient data for mothers and children based on these issues. Regarding earlier studies that created technology with uses for expectant mothers (Ismaeel and Hamead, 2014; Supriyanti et al., 2016). Researchers are working on an app to track the health of expectant mothers who give birth to 5-year-olds. The goal is to provide thorough and accurate patient history information. Monitoring is done to assist identify potential disorders or abnormalities in pregnant women or child malnutrition early. When assisting with birthing, the midwife will act more swiftly.

SUBJECTS AND METHOD

1. Study Design

This study uses a development research design with a Rapid Application Development (RAD) approach. Data collection was

conducted at village-based health facilities where midwives provide maternal and child health services, and integrated health posts. This study was conducted during the period of 2023.

2. Population and Sample

The population in this study included village midwives who actively work in public health services and health cadres at integrated health posts. The inclusion criteria for participants were midwives who had at least five years of experience in providing health services to the community in the village. While the inclusion criteria for health cadres were cadres who were still actively assisting activities at integrated health posts. The sample was selected intentionally to ensure relevance to the research objectives, with a focus on those directly involved in maternal and child health services.

3. Study Variables

The development of this application uses the Rapid Application Development (RAD) approach. The research steps can be shown in Figure 1.
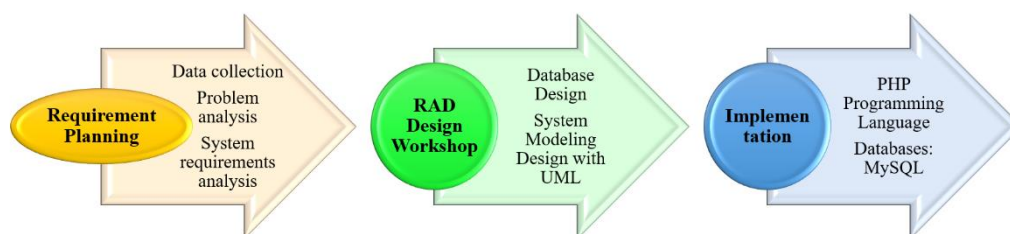

Figure 1. Research stages

Requirement Planning

Researchers collected data through observation and interviews with midwives. Researchers analyzed the need for data on examinations of pregnant women, delivery services, and child examinations. Midwives have an important role in reducing maternal morbidity and mortality (Erawati et al., 2020). The inclusion criteria for midwives in this study were that they were midwives who had worked for at least 5 years serving community health in villages.

Rapid Application Development (RAD) Design Workshop

Researchers make database designs, user interface designs, and input and output process designs. System design uses UML tools in the form of use cases, activity diagrams, sequence diagrams, and class diagrams. The input design provides patient identification forms for pregnant women, husband identities, and child identities.

Every healthcare provider must keep complete patient data as a form of patient medical record (Dang et al., 2014).

Medical record documentation is important and legal based on mobile apps or internet websites (Phillips et al., 2006; Yoo et al., 2023). This is used to archive patient identity, patient history data, and medical or therapeutic actions.

Implementation

Researchers worked closely with midwives. After the application is approved, the application is tested and implemented (Wibowo, 2018). The research team trained midwives and their assistants to operate the app. They input patient data after every patient examination. Training and mentoring are organized so that the performance of health workers can increase (Nur et al., 2021). This methodology is crucial for creating Health technology that is not only practical but also secure and efficient for users (Rahmadhan

et al., 2023).

4. Operational Definition of Variables

Usability and Effectiveness: Defined as the ease of use, accuracy, and functionality of the application in documenting and retrieving patient data, assessed through midwife feedback and system testing results.

Application Design: Refers to the structural and functional features of the application, including database architecture, user interface, and input/ output processes, measured by system evaluation metrics and user satisfaction.

Training: Involves the organized sessions conducted to teach midwives and their assistants to operate the application, measured by the ability of participants to input and retrieve data accurately after training.

5. Study Instruments

The instruments used in this study included observation sheets, interview guides, and application system documentation. Observation and interviews were conducted to gather data on midwives' needs for maternal and child health documentation. Additionally, system evaluation tools, such as usability testing checklists and user feedback forms, were used to measure the application's performance and user satisfaction.

6. Data analysis

Data analysis was conducted quantitatively and qualitatively. Quantitative data from system testing were analyzed using descriptive statistics to evaluate application accuracy, speed, and efficiency. Qualitative data from interviews and user feedback were analyzed thematically to identify strengths, weaknesses, and recommendations for further improvements.

7. Research Ethics

This study involves humans only as informants, not as research objects. So this study does not require ethical approval, except in the form of informed consent from informants. All participants gave informed consent before participating, ensuring their rights and confidentiality were protected. Training sessions and data collection processes were designed to minimize discomfort for participants while respecting their professional roles.

RESULTS

At Posyandu, information was gathered through speaking with and interviewing 30 health cadres and midwives. Results of examinations of pregnant women or infants are among the data collected.
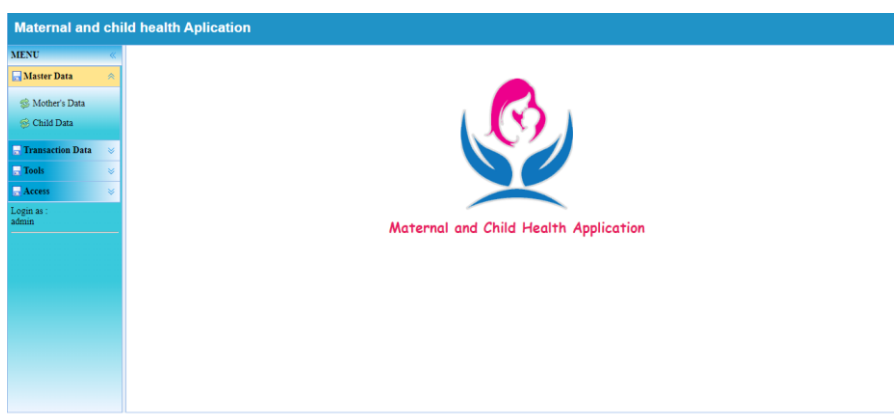

Figure 2. Dashboard of the Electronic-Based Maternal and Child Health Monitoring System

Figure 2 illustrates the dashboard used to record the personal data of both mother and child patients. The dashboard menu includes a "Master Data" section, which contains "Mother" and "Children" data. Additionally, there is a "Transaction Data" menu that features "Pregnancy Examination", "Child Health Examination", and "Infants Growth Curve." This layout ensures easy navigation and efficient tracking of maternal and child health information.

As shown in Figure 3, the midwife inputs the mother's identity data, including name, date of birth, religion, address, education, and occupation. Additionally, the husband's information—such as name, age, education, and occupation—is also recorded. The inclusion of the husband's identity emphasizes the importance of his role in supporting the pregnant woman during antenatal care (ANC) visits, which can positively influence the delivery process (Nuryana et al., 2022).

Furthermore, inputting the results of the physical examination of pregnant women is crucial for identifying potential diagnoses or health issues, enabling immediate and collaborative action, developing a care plan, implementing the care plan, and evaluating its effectiveness (Rahma and Safura, 2016; Tus Sadiah, 2020). Similarly, the physical examination of infants or toddlers plays a vital role in preventing malnutrition and stunting, helping to ensure healthy growth and development (Rohmah et al., 2021).

The main goals of antenatal care (care during pregnancy) are to promote the health of both mothers and babies, detect life-threatening complications, prepare for childbirth, and provide essential health education (Tristanti, 2020). The results of pregnancy check-ups can be presented in various formats, including narrative reports, graphs, diagrams, tables, and other visual representations to enhance understanding and decision-making.

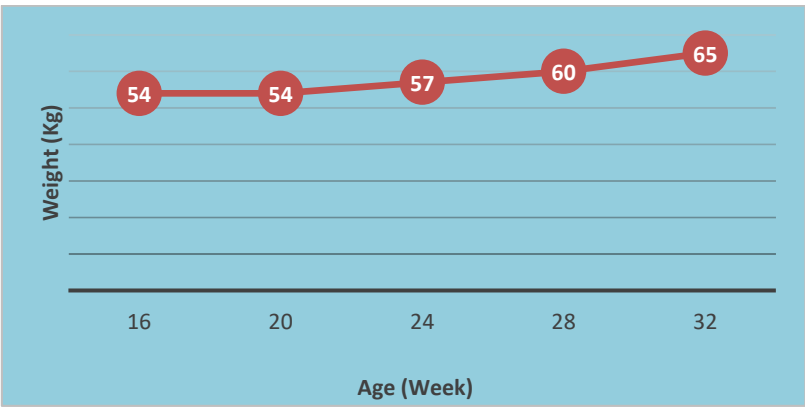**Figure 3. Maternal physical examination results form**

Figure 4. The graphic display of physical examination results

Figure 4 illustrates how data presented in graphical form can assist midwives in analyzing a patient's examination history (Wicahyono et al., 2019). The graph tracks the increase or decrease in maternal weight according to gestational age, which is crucial for detecting malnutrition during pregnancy. Malnutrition can result in low birth weight babies (Harizal et al., 2021), and risk factors associated with birth weight under 2,500 grams are linked to an increased risk of stunting in children under five years old in Indonesia (Fikawati, 2017). This graphical representation is instrumental in detecting abnormal pregnancies, enabling midwives to take immediate medical or therapeutic action when necessary.

In addition to recording the mother's physical examination, this application also stores the child's examination history. This feature was developed to simplify the process for midwives to document the child's medical history, starting from prenatal care through to birth and beyond, ensuring comprehensive tracking of the child's health over time.

Figure 5. Child's physical examination results form

Figure 5 illustrates the results of the child's examination, including the date of visit, weight, height, examination records, and immunization details. It is essential for mothers to regularly bring their children for vaccinations according to their age. Free immunization, vitamins, and deworming services are available for children under five years old through midwives or integrated service posts (Romzah et al., 2021). After conducting a physical examination and entering the data into the application, the child's weight and height history can be visualized in a chart, as shown in the Maternal and Child Health book (Figure 6).
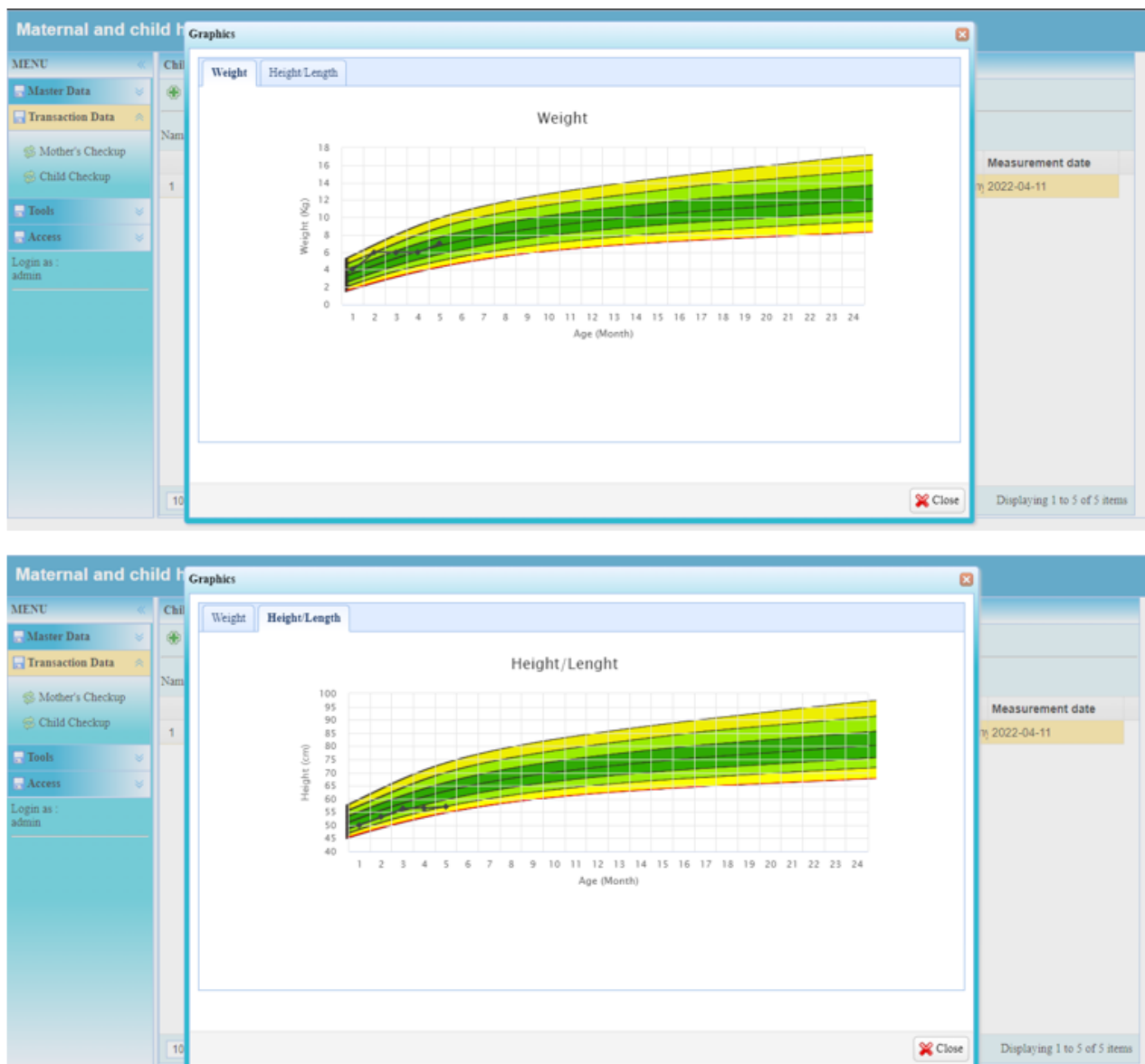

Figure 6. Display of e-child growth curve for children's weight and height

DISCUSSION

To enhance knowledge about stimulating children's growth and development, especially during the toddler years and the critical "golden age," parents—particularly mothers—must make every effort to ensure their children's optimal growth and development (Hutagalung et al., 2021; Tulloh et al.,

2020). The KMS chart is an effective tool for monitoring a child's growth and development. If a child's weight exceeds the expected range for their age, obesity can be identified, which increases the risk of metabolic diseases and motor disorders (Molina-Garcia et al., 2021; Kenney et al., 2020). Conversely, if a child's weight is lower than expected for their age, accompanied by symptoms such as fatigue, lethargy, and motor disturbances, it may indicate malnutrition. Additionally, maternal employment status plays a crucial role in determining child health care practices, which can significantly influence a child's health and development in later life (Yasmeen et al., 2022).

If the electronic-based maternal and child health monitoring system indicates that a child's height is shorter than expected for their age, it is important to be vigilant for signs of stunting. Risk factors for stunting include inadequate diet, lack of exclusive breastfeeding, and insufficient protein and energy intake (Utami, 2020). Despite the known risks, many parents remain unaware of stunting in their children. Therefore, it is crucial to provide health education to mothers and adolescents, as prospective parents, to properly prepare for pregnancy, childbirth, and child-rearing. By increasing knowledge, improving attitudes, and promoting healthy practices among pregnant mothers, nutritional health education programs can help reduce the incidence of stunting in toddlers.

Establishing an accurate diagnosis of abnormalities during pregnancy is crucial to prevent complications such as miscarriage,

malnutrition in pregnant women, and low birth weight (Arayeshgari et al., 2023). To support this, it is essential to have an information system that can store comprehensive records of maternal examinations from pregnancy through delivery, as well as child health data up to five years old. Such a system ensures that health care providers can track and manage maternal and child health efficiently, enabling timely interventions when necessary.

Researchers tested the system on 20 respondents, including midwives and health cadres at Posyandu. The trial incorporated several features, such as a health record system for monitoring the examination history of pregnant women, which includes tracking weight, blood pressure, upper arm circumference (MUAC), and monthly fetal examination results. The system also includes a child's health and growth record features, which tracks weight gain every month. Through the child's growth feature, respondents can detect nutritional status by inputting the child's age, weight, and height.

Testing was conducted using 20 test data points for each process. The results of the initial test showed a 94.4% accuracy rate for detecting nutritional status based on height and weight. The second test, based on the child's age and monthly weight gain, had an accuracy rate of 92.6%. The third test, which considered all features, resulted in a 95.2% accuracy rate, demonstrating the system's effectiveness in detecting nutritional status when all feature data are utilized. The detailed test outcomes are presented in Table 1.

Table 1. Result of Data Testing

Number of Testing Data	Results
Testing 1 (height and weight)	94.4%
Testing 2 (child's age and the child's weight growth every month)	92.6%
Testing 3 (all features)	95.2%

Based on the analysis of the feasibility test of applying the application using the PIECES method, the results are summarized and presented in Table 2. This table provides a comprehensive evaluation of the application's feasibility, assessing various factors such as performance, information quality, economics, control, efficiency, and service quality. Based on the users' feedback, 62.5% of respondents agreed, and 27.3% strongly agreed, resulting in a total of 89.8% of respondents who either agreed or strongly agreed with the feasibility of the application.

Table 2. Respondents' assessment of the application

| Aspect | Respondent Assessment | | | |
	Strongly Agree	Agree	Disagree	Totally Disagree
Performance	29	68	3	0
Information	32	64	4	0
Economic	18	54	28	0
Control	20	64	15	1
Efficiency	30	60	8	2
Services	35	65	0	0
Mean	27.3	62.5	9.7	0.5

This application enables the presentation of patient physical examination history more quickly and accurately. Reports are displayed in graphical form, which can be printed at any time. Through the KMS chart, children's growth can be monitored to assess whether their weight is ideal, or if they are experiencing obesity, malnutrition, or stunting. This allows midwives to detect abnormal patient conditions more efficiently, enabling them to provide immediate health education, medical treatment, therapy, or refer patients to a hospital if necessary (Zulfa et al., 2021).

AUTHOR CONTRIBUTION

The contributions of each author to this research are as follows: Riska Rosita, with expertise in public health, health information management, and quality management, played a key role in designing the study framework, ensuring the application aligns with public health needs, and evaluating its impact on maternal and child health monitoring. Tominanto, specializing in computer science and information systems, contributed to structuring the system's data flow and ensuring the integrity of the digital health records. Siti Farida, an expert in midwifery, provided crucial insights into maternal and child health indicators, ensuring the application's relevance to clinical needs and usability for midwives and health cadres. Andi Yulianto, a computer science graduate, was responsible for the technical development and implementation of the application, including programming and system functionality. And Husna Sarirah Husin, with expertise in web mining, web analytics, and information systems, contributed to optimizing data processing, enhancing system usability, and ensuring that the monitoring features effectively support early detection of stunting risks.

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CONFLICT OF INTEREST

There are no conflicts of interest" or "The authors declare that the study was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest".

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