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Mixed-method development and feasibility analysis of CETING mobile application for digital stunting monitoring

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ABSTRACT

Independent monitoring of toddler growth is a crucial step in stunting prevention; however, conventional methods like the KIA handbook are often perceived as impractical by modern parents. This study aims to develop and evaluate the feasibility of growth monitoring features within the CETING application as a digital solution for early stunting detection. An R&D approach was employed, involving validation by material and media experts, followed by a small-group trial with 15 mothers of toddlers. Data were gathered through Likert-scale questionnaires and in-depth interviews to gain qualitative perspectives. Expert validation indicated high feasibility, with scores of 90.00% from material experts and 85.00% from media experts. The user trial yielded an overall feasibility score of 89.38% (Very Feasible), with "Ease of Use" achieving the highest score (91.25%). Qualitative findings confirmed that users perceived the app as more efficient and accurate than manual methods, supported by an intuitive interface and data synchronization with WHO medical standards. The CETING application is a feasible digital instrument for empowering parents in child health monitoring. Future developments should focus on integrating automated reminder features and expanding trials to groups with diverse digital literacy levels.

1. Introduction

Stunting continues to be a formidable challenge for global public health. According to the World Health Organization (WHO), stunting prevalence becomes a significant concern when it reaches or exceeds 20% among toddlers. In Indonesia, data from the Indonesian Nutritional Status Survey (SSGI) indicates a positive trend, with prevalence dropping from 24.4% in 2021 to 21.6% in 2022 (World Health Organization (WHO), 2018). Despite this decline, the figure remains above the WHO threshold, necessitating more intensive intervention. Factors such as non-exclusive breastfeeding, low socioeconomic status, premature birth, short birth length, and maternal education levels are primary drivers of stunting incidents in Indonesia (Huljannah & Rochmah, 2022). Furthermore, environmental conditions, including inadequate sanitation and lack of treated drinking water, further exacerbate these risks.

The impact of stunting extends beyond physical growth; it severely hinders the development of cognitive and fine motor functions, which are vital for a child's future (Permatasari & Sumarmi, 2018). Since the most rapid brain growth occurs within the first two years of life, nutritional deficiencies during the first 1,000 days of life can lead to permanent developmental delays. A common issue encountered in the field is that when parents visit community health centers (Posyandu), they often do not receive a clear or comprehensive conclusion regarding their child's developmental progress. This lack of clarity, combined with the difficulty many parents face in interpreting the Maternal and Child

Health (KIA) handbook, often results in delayed detection of growth issues (Prendergast, A. J., Humphrey, 2014). Consequently, technology-supported independent monitoring has become crucial for identifying potential delays early on, ensuring that appropriate interventions can be implemented promptly (Scheffler et al., 2021).

In the digital era, mobile applications have proven to be more efficient and effective for providing education and documenting child growth online (Abdulahi M, Fretheim A, Argaw A, 2021). Promoting stunting health education through digital platforms with short, interactive, and easily accessible educational content, complemented by participant comprehension evaluation, offers an effective means to enhance target group knowledge (Nagpur et al., 2021). This research focuses on the enhancement (feature expansion) of the existing CETING (Cegah Stunting) application. The primary objective of this development is to integrate advanced growth and development monitoring features, allowing parents to independently track their child's physical, cognitive, and emotional milestones. Through these added features, the app provides personalized recommendations, nutritional advice, and stimulation exercises tailored to the child's specific developmental stage.

The novelty of this study lies in the application of a mixed-methods approach within the Research and Development (R&D) process and its feasibility analysis. A quantitative approach was employed to validate feasibility through scores from material experts, media specialists, and end-users (mothers of toddlers). Meanwhile, a qualitative approach involving in-depth interviews was used to capture real-world user experiences, ease of use, and the perceived benefits reported by respondents. By adopting this innovative technology, the enhanced CETING application is expected to contribute significantly to more effective and comprehensive stunting management at the family level, serving as the first digital growth mentoring tool implemented in the Perumnas 2 Community Healh Center area to address its high stunting prevalence.

The research was conducted using a Research and Development (R&D) framework, specifically adopting the ADDIE model which encompasses Analysis, Design, Development, Implementation, and Evaluation. To provide a robust assessment of the application, we integrated a mixed-methods approach that combined quantitative metrics with qualitative insights. This allowed for a comprehensive evaluation where statistical data from feasibility scores were enriched by the nuanced perspectives of end-users regarding their practical experiences with the digital tool. The detailed execution and outcomes of each ADDIE phase are systematically described and discussed in the Results and Discussion section.

The execution of the ADDIE stages was conducted systematically, beginning with the Analysis and Design phases. In the Analysis phase, utilizing preliminary data from the local community health center (Puskesmas), we identified a critical gap: despite brief explanations from health volunteers (kader), mothers still lacked definitive information on whether their children fell into stunting risk categories. To address this in the Design phase, we drafted a user interface (UI) prioritized for parental ease of use, ensuring that the workflow remained intuitive for users with varying levels of digital literacy. Specifically, the UI was optimized to be text-minimal, focusing on automated visual growth charts, an automated conclusion of the child's growth status, and immediate actionable recommendations if a stunting risk is identified. Moving into the Development phase, our team focused on the technical integration of WHO-standardized growth algorithms.

The field trial took place between May and June 2025, involving 15 mothers of toddlers within the Perumnas II Health Center area in Pontianak, selected through purposive sampling. In addition to the end-users, the system underwent a rigorous validation process involving four material experts specifically midwives and nutritionists to ensure content accuracy, and three media experts to evaluate the technical UI/UX performance. Primary data were gathered through a combination of observation, structured questionnaires, and in-depth interviews. Quantitative assessments were measured using a 4-point Likert scale to determine feasibility percentages, while qualitative interviews served to triangulate the findings, offering a deeper understanding of how the digital platform compared to traditional methods like the KIA handbook. Data analysis was performed descriptively, categorizing results as "Very Feasible" if the final scores fell within the 81–100% range.

2. Results and Discussion

3.1 Feature development and visual implementation

The R&D phase successfully integrated advanced growth monitoring features into the existing CETING application framework. These enhancements include a user-friendly tracking interface, an automated stunting detection algorithm based on WHO standards, and a database providing personalized nutritional and stimulation recommendations. The system now offers visual growth charts and real-time screening status to facilitate independent early detection by parents. The visual appearance and user interface of these newly developed features within the CETING application are presented in Fig. 1.

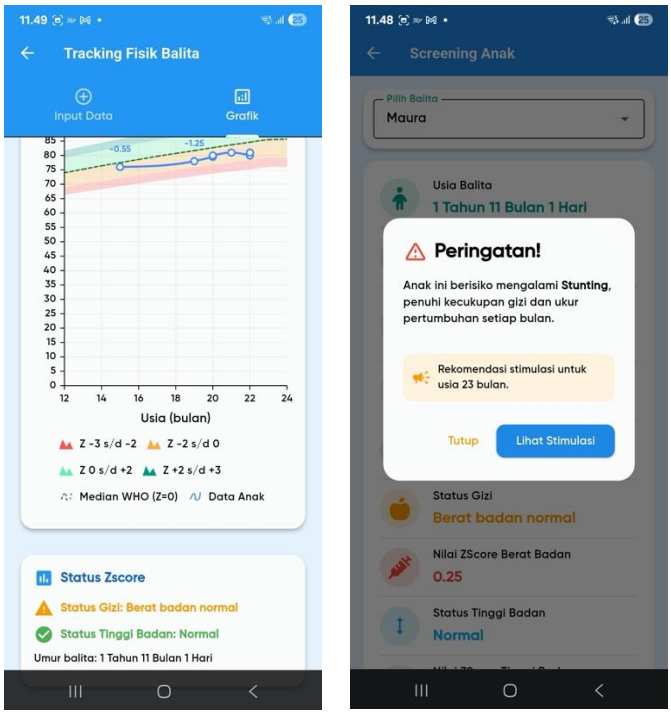

Fig. 1. The CETING application interface: (a) Automated visual growth chart, (b) Actionable recommendations.

3.2 Feasibility validation by experts

The system underwent rigorous evaluation through structured questionnaires using a 4-point Likert scale.

Table 1. Material expert validation results

Assessment Aspect	Mean Score	Percentage (%)	Category
Instructional quality	3,65	91,25	Very feasible
Information accuracy	3,50	87,50	Very feasible
Content relevance	3,60	90	Very feasible
Average total	3,60	90	Very feasible

Material experts (nutritionists and midwives) confirmed the validity of the content, with the highest score achieved in instructional quality (91.25%), highlighting the app's capability to provide risk warnings and monitoring reminders.

Table 2. Media expert validation results

Assessment Aspect	Mean Score	Percentage (%)	Category
Layout and design	3,50	87,50	Very feasible
Navigation ease	3,30	82,50	Very feasible
Information availability	3,40	85	Very feasible
User interactivity	3.40	85	Very feasible
Average total	3,40	85	Very feasible

Media experts focused on the interface, where "Layout and Design" earned the highest rating (87.50%) due to its aesthetic clarity and intuitive elements.

3.3 End-user feasibility and Perception

Table 3. User trial results

Assesment Aspect	Mean Score	Percentage (%)	Category
Ease of use	3,65	91,25	Very feasible
User satisfaction	3,50	87,50	Very feasible
Information relevance	3,60	90	Very feasible
User engagement	3.55	88,75	Very feasible
Average total	3,58	89,38	Very feasible

The small-group trial recorded a high acceptance rate of 89.38%, categorized as "very feasible," providing empirical validation that the CETING application's growth monitoring features are ready for implementation. This feasibility is primarily driven by ease of use and accessibility, which empower mothers to conduct independent monitoring. Furthermore, the app's real-time screening capabilities have proven effective in increasing user awareness and reinforcing trust in digital health solutions.

3.4 Qualitative Findings from End-Users

To provide a more granular understanding of these outcomes, the qualitative phase of the study uncovered several key themes that reflect the specific lived experiences and thematic perceptions of the participants.

Theme 1: Ease of use and accessibility

The majority of participants reported no significant difficulties when operating the features. Respondents emphasized the app's simplicity; for instance, Mrs. DE described it as "*very easy and simple to understand*," while Mrs. SI stated, "*Fortunately, it's easy, not difficult, easy to understand, without many errors, it's just great.*" This ease of use stands in direct contrast to conventional monitoring methods, as the application is perceived to be significantly more practical and efficient. Mrs. NW compared the two, noting, "*the app is much easier; we just search and it appears immediately. With manual recording, it's hard because we have to open the book first*."

Theme 2: Data accuracy and trust in information

The high quantitative score for information relevance and readability is significantly reinforced by the users' profound trust in the accuracy of the data provided by the application. This perceived reliability is a critical factor, as mothers reported that the nutritional status and growth information displayed was both precise and consistent with trusted medical sources. For instance, Respondent DE noted that the information was *"highly accurate, easy to understand, and perfectly matched [her] child's condition."* This confidence is often established through independent cross-verification; Participant DE further explained that her trust stemmed from observing that the app's growth charts were identical to the records in her physical Maternal and Child Health (KIA) book. Such consistency with professional medical assessments was also highlighted by Respondent ES, who expressed no doubt about the app's output as it aligned with previous evaluations by her pediatrician.

Theme 3: Interaction, Engagement, and Digital Advantages

The user interaction and engagement aspect suggests that the CETING feature successfully fosters more active, independent, and sustainable monitoring behaviors. The application offers a level of flexibility absent in printed media. Mrs. SI highlighted the benefits of real-time monitoring, noting, *"the book is only checked during Posyandu visits, but with a phone, it can be accessed at any time."* This flexibility directly motivates users to input data more frequently. Mrs. DE affirmed this, stating, *"I will definitely input data into the app more often so I can track my child's progress as well."* Participants also emphasized the comparative advantages of digitalization over the conventional KIA handbook. Mrs. AS noted, *"I rarely read the KIA book... I think this is superior,"*adding, *"I also rarely open the KIA book.*

Discussion

Comparatively, digitalization through CETING offers efficiency and modern lifestyle integration that is significantly more practical than conventional methods like the KIA handbook. The quantitative finding showing the highest score in "Ease of Use" (91.25%) is strongly corroborated by the qualitative evidence from user interviews. These insights validate the success of the user-friendly design, which empowers mothers to monitor their child's growth independently without requiring external assistance. Research has consistently shown that users prefer applications offering features such as personalization, social support, and user control. These characteristics are identified as critical factors in enhancing user engagement with digital health platforms (Gadgil et al., 2022). Furthermore, integrating user-centered design principles can address broader healthcare system challenges, effectively improving both the usability and accessibility of the application (Erjavec et al., 2025).

The lack of technical obstacles identified in this small-group trial is substantial because a significant barrier to the successful implementation of digital health apps is the historical lack of focus on usability testing prior to product launch. Literature suggests that specialized usability measurement tools, such as the Medical App Usability Questionnaire (MAUQ), are rarely utilized in existing research (Hajesmaeel-Gohari et al., 2022). Other research has frequently identified technical instability, complex navigation, and system failures as primary inhibitors of mHealth adoption. Conversely, the CETING application effectively overcomes these challenges by ensuring system stability and maintaining an intuitive interface accessible to users with varying levels of digital literacy (Alzghaibi, 2025). From an accessibility standpoint, cost-efficiency and convenience are vital considerations for low-income users, underscoring the necessity for applications that can bridge health equity gaps (Giebel et al., 2023). This inclusive approach mirrors technology adoption metrics in other vulnerable populations where a high willingness is demonstrated to adopt technology for independent health self-management (Park et al., 2025).

The high quantitative score for information relevance and readability (90.00%) is directly supported by maternal confidence in the platform's outputs (Radcliffe et al., 2021). The CETING application's ability to consistently generate accurate growth and nutritional status data significantly enhances maternal trust in digital health systems. This structural consistency over time effectively minimizes the human error and data distortion often associated with manual paper recording. Digital anthropometry systems significantly reduce human error in measurements compared to manual methods (Kuntuamas & Huriah, 2025). Data accuracy and consistency in health applications are fundamental cornerstones for supporting Clinical Decision Support Systems (CDSS) and improving the overall quality of healthcare services. Digital technologies improve the precision of growth disorder management through automated tracking (Dunkel et al., 2021). By providing dependable information, CETING empowers users to track health parameters independently, which encourages monitoring compliance and facilitates long term health management (Conway & Kelechi, 2017; Izaturwanaho et al., 2025). In the Indonesian context, mHealth interventions effectively improve maternal knowledge and childcare practices, reinforcing the value of reliable data in fostering long-term engagement within digital health ecosystems (Siswati et al., 2022).

The minimal technical barriers encountered by CETING users are particularly significant when analyzed through the lens of the Complexity Theory from the Diffusion of Innovations (Brar et al., 2020). Complexity refers to a user's perception of an innovation's difficulty; given the low complexity of the CETING app, the potential for technological adoption among mothers is significantly enhanced (Imlawi, 2023; Mashoufi et al., 2018). Furthermore, according to the ISO 9241-11 usability framework, CETING satisfies the dimensions of effectiveness (achieving health recording objectives), efficiency (requiring minimal time and effort), and user satisfaction (providing a consistently positive experience). The app's real-time screening capabilities have proven effective in increasing user awareness and reinforcing trust in digital health solutions (International Organization for Standardization., 2018). Collectively, these factors encourage proactive engagement and enhance digital literacy among mothers, supporting more sustainable child development monitoring.

The lack of technical obstacles identified in this study contrasts with previous literature that underscores the critical role of app stability and usability in digital health implementation. Other research has identified technical instability, complex navigation, and system failures as primary inhibitors of mHealth adoption. Conversely, the CETING application effectively overcomes these

challenges by ensuring system stability and maintaining an intuitive interface accessible to users with varying levels of digital literacy.

Despite demonstrating a high level of feasibility, this study acknowledges several technical and methodological limitations that warrant consideration. From an app functionality standpoint, the current CETING platform lacks an integrated automated reminder system (push notifications), requires full internet connectivity to operate optimally, and is exclusively available to Android users. Furthermore, the small-group trial conducted in this study only evaluated usability on modern Android devices, thereby leaving system performance and stability on older Android operating systems untested. These constraints provide a critical foundation for future research directions, which will focus on integrating automated notifications, developing offline access capabilities, expanding cross-platform compatibility (iOS), and conducting large-scale usability testing across a wider variety of device specifications.

3. Conclusion

The development of monitoring features in the CETING application successfully fulfills the initial objective of providing a digital solution for early stunting detection. With a feasibility rate of 89.38%, the results demonstrate a strong alignment between the research goals and practical user needs. Based on this robust statistical support, it is highly recommended that the CETING application be scaled up for broader implementation at the community health center (Puskesmas) level and formally adopted by community health volunteers (kader) as a standardized digital tool for growth mentoring. Future research prospects could focus on integrating automated reminder notifications for routine monitoring schedules and conducting further trials among user groups with diverse digital literacy levels to ensure the application remains accessible and easy to use across different segments of society.

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