Feasibility Analysis of Machine Learning-Based Smart Stunting Application

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ABSTRACT
Stunting is a chronic nutritional condition that requires rapid and accurate early detection. Conventional assessment methods that rely on the Indonesian Maternal and Child Health (MCH) handbook; commonly referred to as the MCH handbook or manual anthropometric tables often face challenges related to efficiency and susceptibility to human error. The digitization of anthropometric assessment through an Android-based application offers a promising solution for automating the evaluation of toddlers' nutritional status. This study aimed to examine the perceived benefits and user acceptance of a machine learning–based Android application designed for stunting detection and management. A descriptive quantitative design was employed. Consecutive sampling was used to recruit individuals who met the inclusion criteria, including the ability to operate the designated Android system, resulting in a sample of 37 respondents. Data were collected using a structured questionnaire with a 1–4 Likert scale. Descriptive statistics were applied to generate frequency distributions, percentages, and mean scores for the indicators of accuracy, usability, utility, and reliability. Findings indicate a high level of user acceptance. Usability received the highest mean score (3.28), followed by utility (3.25) and reliability (3.16). A total of 91.7% of respondents rated the prediction system as accurate, with an average accuracy score of 3.05. Respondents also reported that the application was substantially more efficient and faster than manual assessment methods. In conclusion, the machine learning–based stunting detection application effectively supports users in identifying stunting risk quickly and accurately. Its ease of use and strong perceived validity make it a practical tool for both healthcare workers and the general public, contributing to efforts to accelerate stunting reduction.
Keywords: anthropometry; Android-based application; machine learning; stunting

INTRODUCTION
Stunting is a form of chronic growth impairment in which a child's height falls significantly below the expected standard for their age, reflecting long-term nutritional deprivation and recurrent illness. A toddler is classified as short when their length-for-age (LFA) or height-for-age (HFA) Z-score is less than –2 SD (stunted) or less than –3 SD (severely stunted). These Z-scores are derived from standardized anthropometric measurements, which serve as essential indicators for evaluating body size, proportions, and composition. Length-for-age and height-for-age indices are widely used to categorize children as very short, short, normal, or tall, and they remain the cornerstone of child growth monitoring systems worldwide [1]. In Indonesia, stunting continues to be a major public health concern, largely driven by chronic malnutrition during the first 1,000 days of life; a critical developmental window that determines long-term health outcomes. Chronic malnutrition has persisted as one of the most pressing challenges in the national health sector, affecting not only individual well-being but also broader socioeconomic development [2,3].

Global trends indicate gradual progress in reducing stunting. According to the World Health Organization (WHO), the global prevalence of stunting declined by 22.3% between 1990 and 2022, reaching 17.9% in 2022 [4]. Indonesia has also demonstrated significant improvement, with prevalence decreasing from 30.8% in 2018 to 21.5% in 2023 [5]. At the regional level, Yogyakarta City reported a stunting prevalence of 10.6% as of 30 July 2024, showing improvement from 11.8% in 2023 [6]. Despite these positive trends, stunting remains a priority issue within national and global health agendas. It is included as a key indicator in the Sustainable Development Goals (SDGs), with a global target of achieving a 40% reduction in stunting among children under five by 2025 [7]. The persistence of stunting, even amid declining prevalence, underscores the need for sustained, innovative, and evidence-based strategies to accelerate progress.

The consequences of stunting extend far beyond impaired physical growth. Children who experience stunting are at increased risk of delayed cognitive development, reduced school performance, lower future productivity, and diminished quality of life. These long-term impacts highlight the importance of early identification and timely intervention. Effective stunting prevention requires an integrated approach grounded in accurate, reliable, and accessible data [8]. Early detection plays a pivotal role in this process, enabling health workers and caregivers to identify at-risk children before growth faltering becomes irreversible. However, current early detection efforts often encounter substantial barriers. Manual anthropometric assessments using the Maternal and Child Health (MCH) handbook or printed growth charts are time-consuming, prone to human error, and dependent on the availability of trained personnel. In many settings, limited human resources, inconsistent measurement practices, and restricted access to digital health tools hinder the efficiency and accuracy of stunting detection.

Advancements in digital health technologies offer promising opportunities to address these challenges. Machine learning-based detection systems integrated into smartphone applications can enhance the precision, speed, and accessibility of anthropometric assessments. By automating the interpretation of growth data, such systems reduce reliance on manual calculations and minimize the risk of misclassification. Moreover, smartphone-based applications can facilitate broader community engagement, allowing caregivers and health workers to access reliable information and recommendations directly from their devices. These innovations support the development of data-driven policies and strengthen the capacity of health systems to respond to stunting more effectively [9]. As digital transformation accelerates within the health sector, ensuring that new technologies are both beneficial and acceptable to users becomes increasingly important.

Therefore, this study aimed to evaluate the perceived benefits and user acceptance of a machine learning–based Android application designed for stunting detection and management, focusing on its accuracy, usability, utility, and reliability from the user perspective.

METHODS
This study was conducted in 2025 in Yogyakarta, Indonesia, where the Smart Stunting application was tested among community members and individuals familiar with Android-based devices. The feasibility assessment was carried out in collaboration with the Sekolah Tinggi Ilmu Kesehatan Panti Rapih Yogyakarta and supported by field implementation activities within the local community setting. A quantitative research

design with a descriptive analytical approach was employed. This design was selected to provide a systematic and comprehensive overview of user perceptions related to the accuracy, usability, utility, and reliability of the machine learning–based Smart Stunting application. The study did not involve hypothesis testing; instead, it focused on describing response patterns and feasibility indicators derived from user experiences.

The feasibility test involved human participants selected through a consecutive sampling technique. Individuals were recruited based on predetermined inclusion criteria: 1) owning and being able to operate an Android device; 2) willingness to download, install, and use the Smart Stunting application; 3) willingness to participate as respondents; and 4) willingness to complete the structured questionnaire. Exclusion criteria included respondents who experienced technical difficulties related to device incompatibility, particularly unsupported Android versions. After applying these criteria, a total of 37 respondents were included in the final analysis.

Data were collected using a structured questionnaire consisting of 30 items distributed across 11 sections and grouped into four assessment domains: accuracy, usability, utility, and reliability. All items were measured using a 1–4 Likert scale, where higher scores indicated more positive perceptions. The instrument had previously undergone validity and reliability testing and was confirmed to be appropriate for feasibility assessment. The research process comprised several sequential stages: 1) initial data collection and processing using the machine learning model output embedded in the Smart Stunting application; 2) selection and evaluation of the machine learning algorithm used for prediction; 3) system testing to ensure functional stability; and 4) feasibility testing through user interaction with the application followed by questionnaire completion. Respondents were guided to install the application, input anthropometric data, and observe the prediction results before completing the questionnaire.

Collected data were analyzed descriptively using frequency distributions, percentages, and mean scores for each indicator. These descriptive statistics were used to identify response tendencies and categorize user perceptions. Interpretation of results was supported by a score-interval table, enabling accurate identification of achievement levels for each domain. This analytical approach provided strong baseline evidence for evaluating the feasibility and acceptance of the machine learning–based application.

RESULTS

The results of this study present an overview of the results of the feasibility analysis and a summary of the feasibility analysis table from the results of data collection on 37 respondents as follows (Figure 1-11).

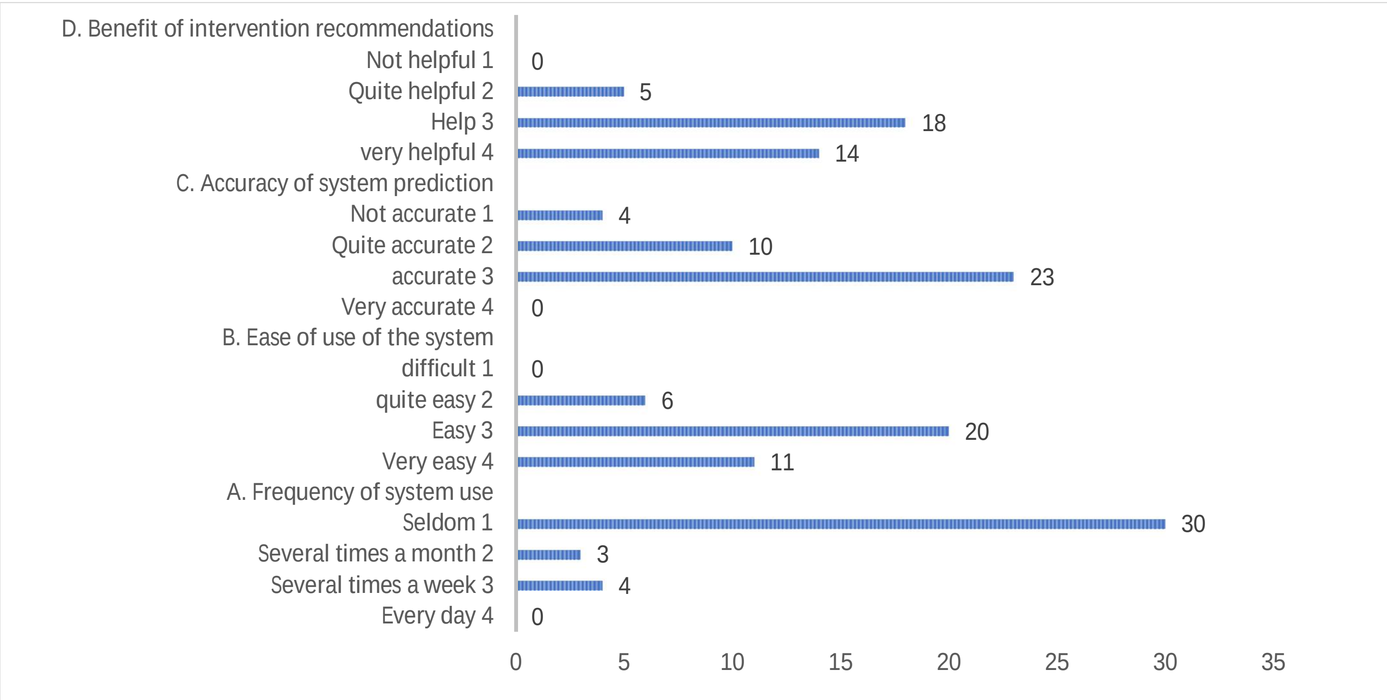

Figure 1. System usage

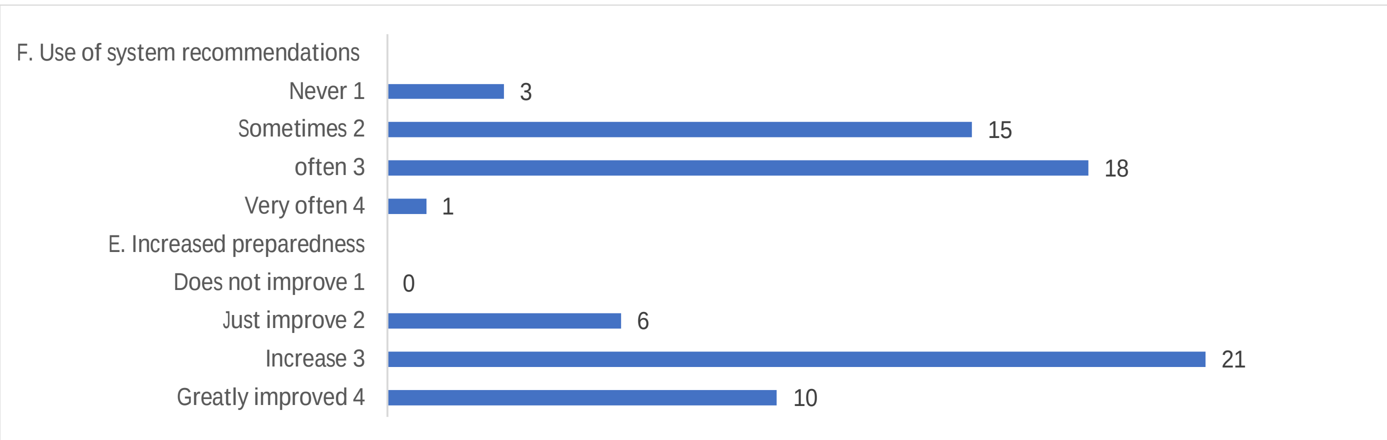

Figure 2. Impact of application use

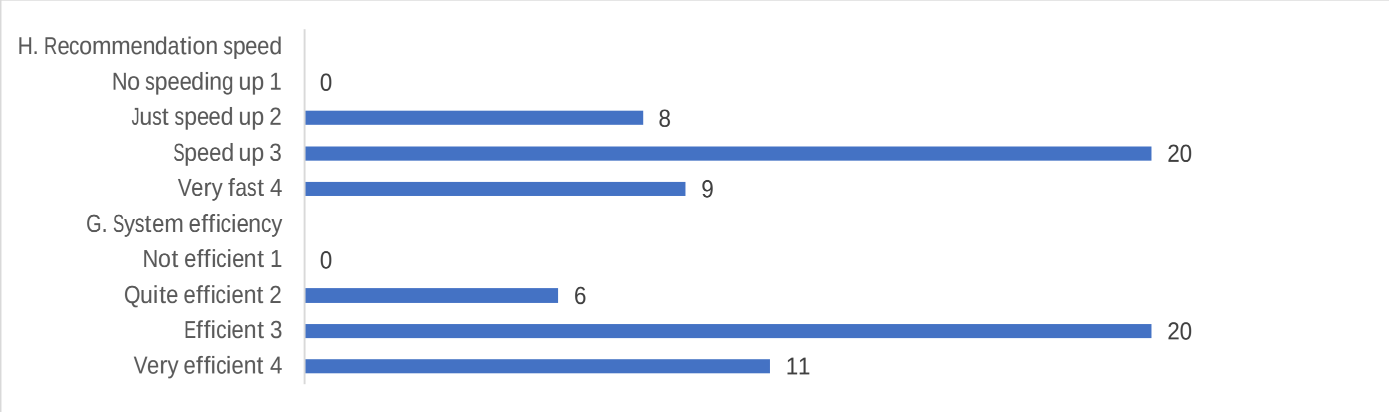

Figure 3. Benefits of technology

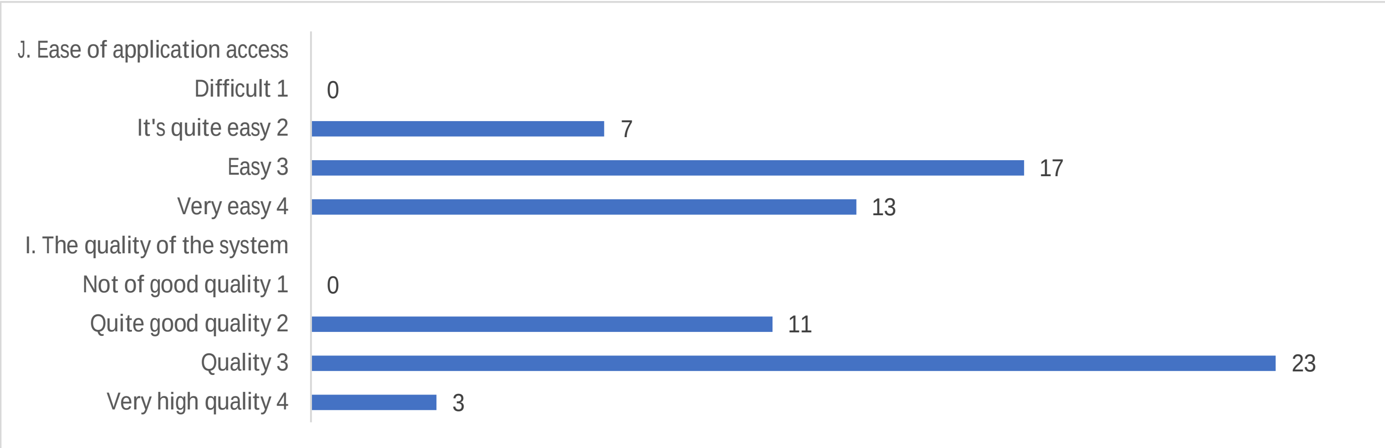

Figure 4. Data quality and access

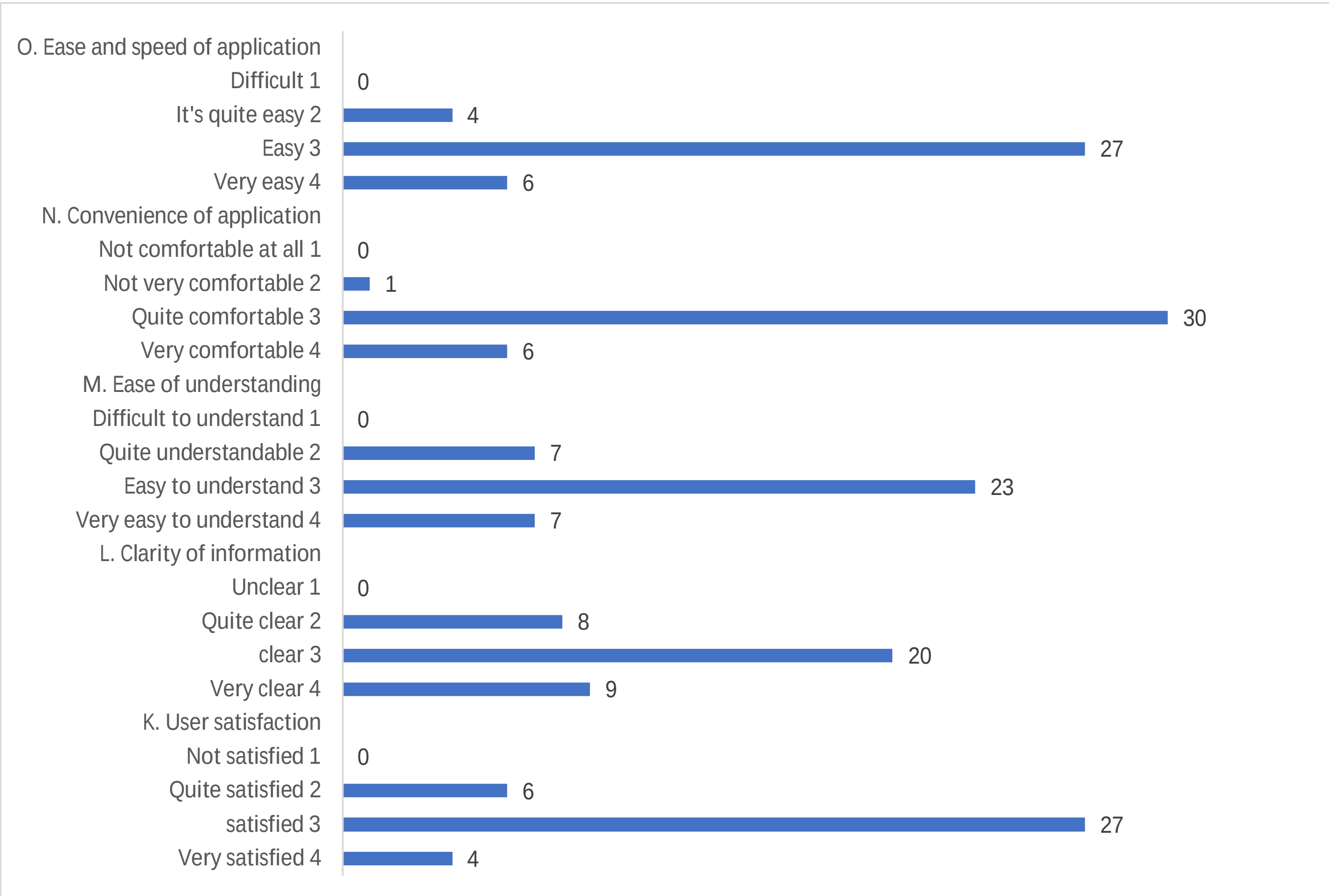

Figure 5. User experience

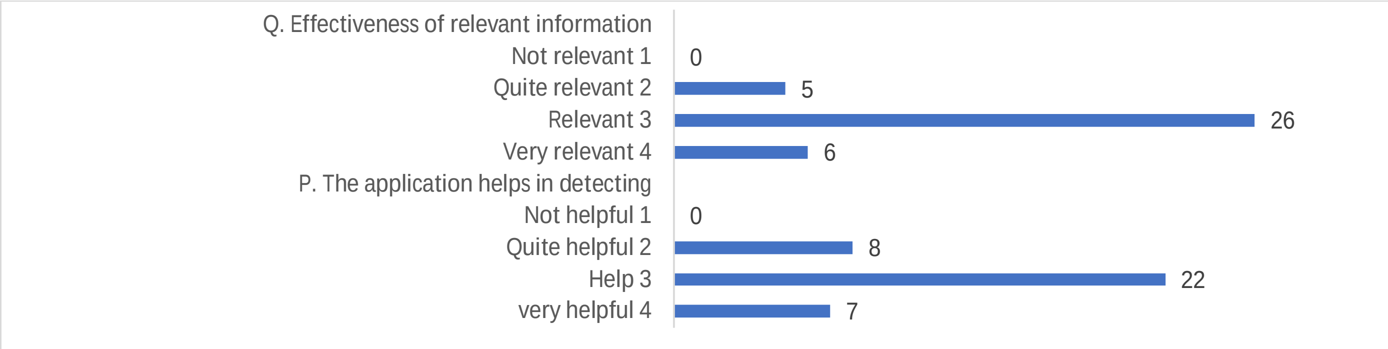

Figure 6. System effectiveness

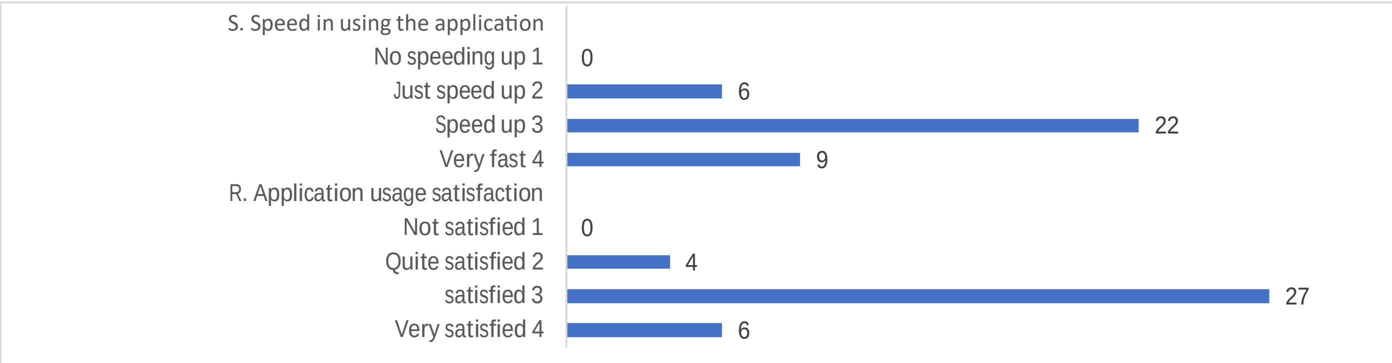

Figure 7. User satisfaction and overall experience

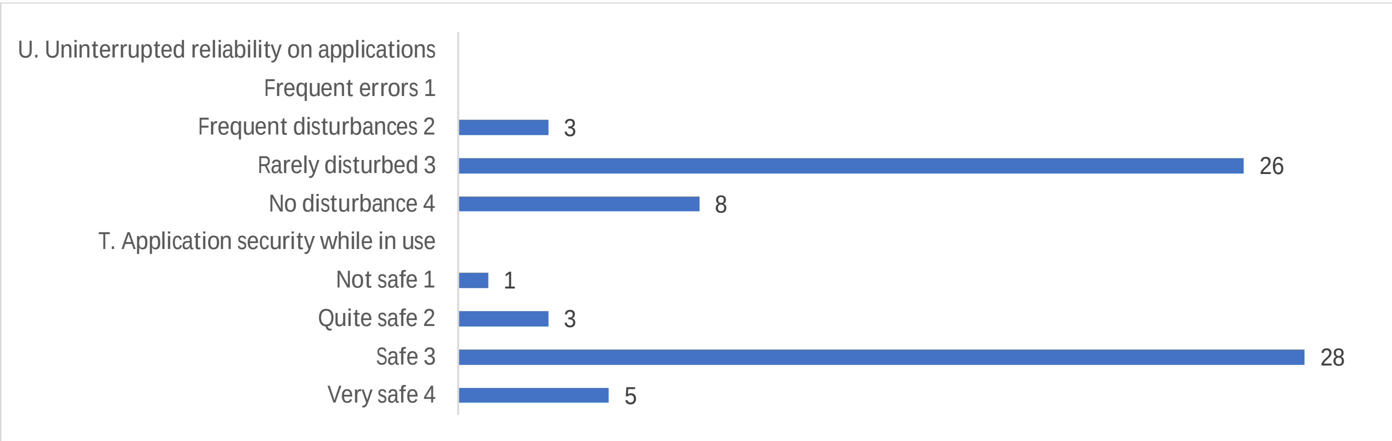

Figure 8. Application reliability and security

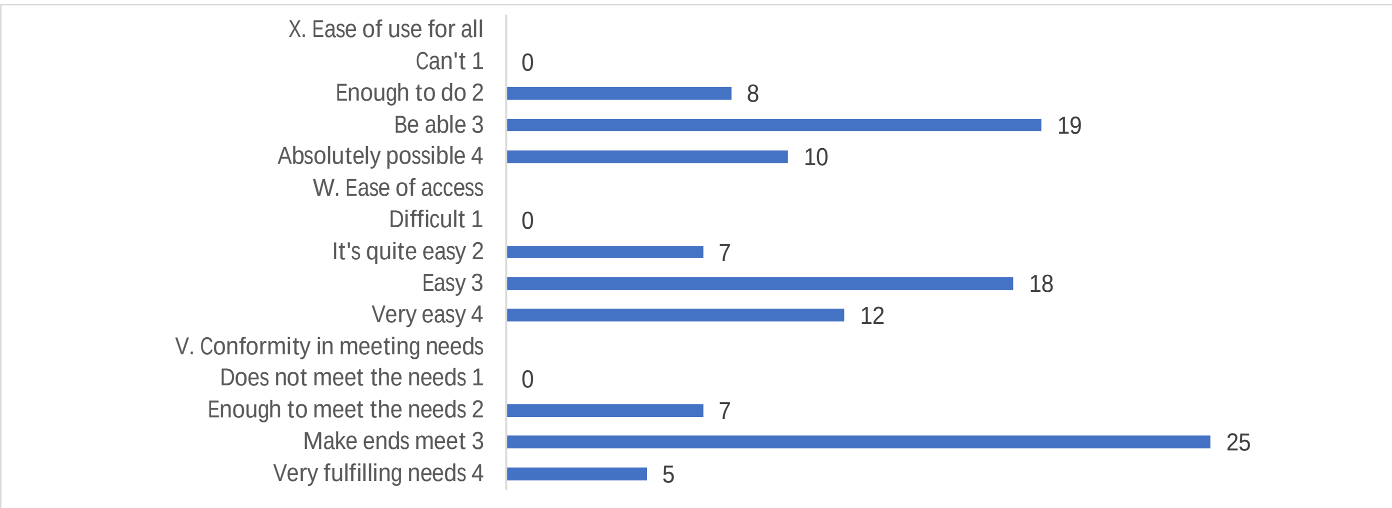

Figure 9. Compliance with user needs

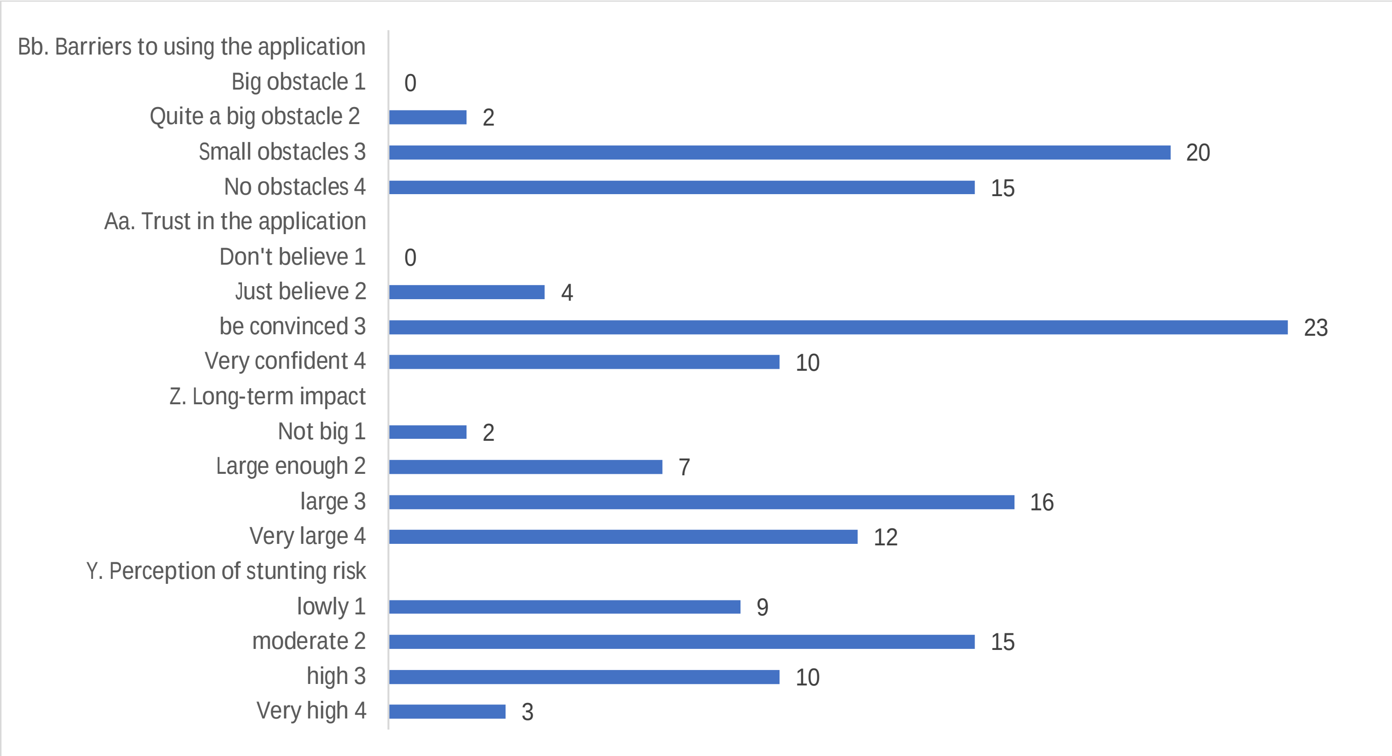

Figure 10. Perception of risk and benefits

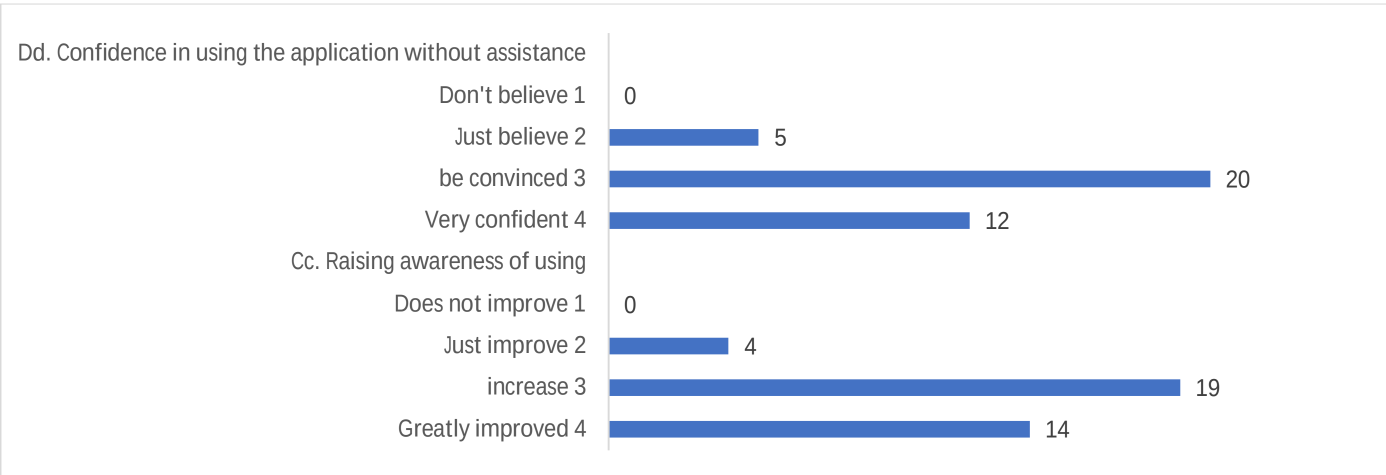

Figure 11. Motivation for using the application

Based on the analysis of Figures 1–11, the indicators show that the visualisation of the usage and impact of Figures 1–4 demonstrates the positive impact of the application's users on efficiency, the benefits of the technology, as well as data quality and ease of access via the system. The experience and effectiveness shown in Figures 5–8 indicate a positive user experience, the system's operational effectiveness, user satisfaction, and the reliability and data security guaranteed by the application. The perceptions and motivation shown in Figures 9–11 represent the suitability of the application's features to users' actual needs, the balance between perceived risks and benefits, and the high level of motivation among respondents to continue adopting this application for nutritional monitoring.

Based on the data presented in Table 1, it can be concluded that respondents' assessments of the stunting detection and management application show a consistently positive trend across all key indicators. Regarding the accuracy indicator, the majority of respondents provided positive feedback, with 63.9% (23 people) rating it as 'accurate' and 27.8% (10 people) rating it as 'very accurate'. With an average score of 3.05, it is evident that the system is highly reliable in calculating the nutritional status of infants based on anthropometric data inputs. Furthermore, the usability indicator recorded the highest average score of 3.28. A total of 44.4% of respondents rated the application as 'very easy' to operate, while 38.9% rated it as 'easy'. This high score indicates that the application's user interface (UI) and navigation have been intuitively designed, thereby minimising technical barriers for users in the field. Regarding the utility, the research findings suggest that this application contributes to simple clinical decision-making processes. Half of the repondents (50%) found it 'helpful' and 38.9% found it 'very helpful'. An average score of 3.25 suggests that users consider the treatment recommendations provided by the application to be relevant and applicable as an initial course of action. Finally, regarding reliability, an average score of 3.16 was obtained. The majority of respondents (63.9%) stated that they trust the output generated by the app. A key finding of this study is that none of the respondents (0%) stated that they did not trust the results. This confirms that this machine learning–based stunting detection app is viewed as a credible digital tool to support programmes aimed at reducing stunting rates and has an excellent level of acceptance.

Table 1. Respondents' assessment of the stunting detection app (n=37)

Assessment indicator	Answer category	Frequency	Percentage	Average score	Interpretation
Accuracy	Very accurate (4) Accurate (3) Quite accurate (2) Inaccurate (1)	10 23 3 0	27.8 63.9 8.3 0	3.05	Accurate
Usability	Very easy (4) Easy (3) Quite easy (2) Hard (1)	16 14 6 0	44.4 38.9 16.7 0	3.28	Very easy
Utility	Very helpful (4) Helpful (3) Quite helpful (2) Not helpful (1)	14 18 4 0	38.9 50.0 11.1 0	3.25	Helpful
Reliability	Highly reliable (4) Reliable (3) Quite reliable (2) Unreliable (1)	10 23 3 0	27.8 63.9 8.3 0	3.16	Reliable

DISCUSSION

One way of interpreting stunting is through data derived from height-for-age anthropometric measurements taken by healthcare workers. The WHO promotes an online system that facilitates the analysis of children's anthropometric data. The WHO Anthro Survey Analyser aims to encourage best practice in collecting, analysing and reporting anthropometric data [10]. This WHO software comprises three components: an anthropometric calculator, an individual assessment tool, and a nutrition survey tool. Although Indonesia has adopted anthropometric standards and nutritional status measurement outcomes based on WHO guidelines, these are still recorded manually in the MCH handbook [1]. In light of this, an Android application based on machine learning has been developed to simplify and supplement content related to anthropometry, adopting the WHO application; particularly with regard to anthropometry with a primary focus on nutritional status in cases of stunting.

Machine learning (ML) is a branch of artificial intelligence which uses valid data to enable accurate and rapid decision-making and problem-solving [11]. Research findings support the effectiveness of this anthropometry-based machine learning approach in detecting stunting in children [12]. This study applied ML methods by beginning with the input of baseline data from two regions; Central Java (Banyumas) and the Special Region of Yogyakarta regarding factors that may contribute to stunting. This was followed by data collection and processing. The machine learning algorithm system was developed using the WHO's system for interpreting anthropometric data and was supplemented with appropriate interventions based on the MCH handbook, ensuring suitable efforts to prevent stunting. Random forest and neural network algorithms were used for multivariate analysis, as the data is quite complex. System testing utilised a testing framework for Android applications, while the validation of ML model results was carried out manually by healthcare workers. The next stage involves implementation and pilot testing to analyse the accuracy of the predictions and users' acceptance of the application.

The results of this study indicate that the Android-based stunting detection and management application utilising a machine learning approach received a very positive overall response from all 36 respondents. Based on all evaluation criteria, the application achieved an average score above 3.00 (out of 4). These key findings suggest that the system developed has met user expectations in terms of functionality and information accuracy. The dominance of responses in the 'accurate' (63.9%) and 'easy' (44.4%) categories demonstrates that the application successfully addresses the main challenge of the early detection of stunting: the need for a precise yet simple-to-operate screening tool. This high level of acceptance suggests that the digitisation of anthropometric procedures is viewed not only as a technical aid, but also as a credible instrument for monitoring the nutritional status of infants. Other research findings also suggest that machine learning-based applications offer excellent system, information, and service quality, providing a benefit score of 98% [13]. This supports the view that this ML-based Android application greatly facilitates user experience, with the system achieving a high score for its results..

Regarding the usefulness of the intervention, the study results show that this application makes a significant contribution to the simple clinical decision-making process. Fifty percent of respondents found it "helpful." An average score of 3.25 indicates that the treatment recommendation feature provided by the application is considered relevant and can be applied by users as an initial treatment step. Finally, regarding the aspect of public trust, an average score of 3.16 was obtained. The majority of respondents (63.9%) stated that they "trust" the output produced by the application. This confirms that this machine learning-based stunting detection application has a very good level of acceptance and is seen as a credible digital tool to support the stunting reduction program. The study also stated that the development of machine learning models is very useful and relevant for predicting whether a child will experience stunting or not in the future [13]. This condition is supported by research that with the existence of machine learning-based applications, the public can use them without time or space constraints [14].

The application plays an important role in supporting stunting prevention efforts because it provides users with accurate assessments and context-appropriate solutions. Digital precision has become increasingly attainable in anthropometric evaluation, particularly in the calculation and interpretation of Z-scores. The World Health Organization has long introduced digital tools for anthropometric analysis, demonstrating how modernization can substantially reduce human error in manual measurement and interpretation processes [14]. In this context, technology serves not only as a computational aid but also as a catalyst for improving early detection, enhancing real-time monitoring, and expanding public access to nutrition education through interactive digital platforms [15–21]. The findings of this study further emphasize the high utility of the Smart Stunting application, especially its ability to provide intervention recommendations aligned with the MCH handbook. This feature is crucial because, for the general public and community health workers, identifying a child as "stunted" is insufficient without clear guidance on appropriate follow-up actions, such as referral pathways or nutritional improvement strategies. By offering structured recommendations, the application strengthens decision-making at the community level and functions as an accessible digital health education medium (m-Health). Its role in bridging information gaps highlights the potential of digital innovations to support both preventive efforts and community empowerment in addressing stunting.

CONCLUSION

The Android-based stunting detection and management application was well received and viewed as highly effective by users. They reported that the system successfully modernizes conventional stunting assessment into a faster and more intuitive digital process while reducing the likelihood of human error. The inclusion of intervention recommendations was considered particularly valuable, as it strengthens preparedness for addressing nutritional problems at both family and community levels. This m-Health innovation enhances the efficiency of early detection compared with manual methods and holds strong potential to support national efforts to accelerate stunting reduction. The application can also assist families in monitoring children's growth trends over time. Future studies are encouraged to evaluate the application in larger and more diverse populations, especially in frontier, outermost, and underdeveloped regions where access to healthcare personnel is limited, to further assess its performance stability.

Ethical consideration, competing interest and source of funding

-All research procedures adhered to ethical standards for studies involving human participants. Ethical approval was obtained from the Health Research Ethics Committee (KEPK) of Panti Rapih Hospital Yogyakarta, with approval number 177/SKEPK-KKE/VII/2025. Participation was voluntary, and respondents were informed about the study objectives, procedures, and confidentiality measures. Informed consent was obtained prior to data collection.

-There is no conflict of interest related to this publication.

-This research was funded by Sekolah Tinggi Ilmu Kesehatan Panti Rapih Yogyakarta and Sekolah Tinggi Ilmu Komputer Yos Sudarso through their internal grant programs.

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