

SI-GEMBUL: A Mobile Nutrition Information System to Strengthen Early Childhood Stunting Detection in Indonesia

Vilda Ana Veria Setyawati^{1*}, Eti Rimawati¹, Agung Wardoyo¹, Ririn Nurmandhani¹, Muhammad Iqbal¹, Sylvia Anjani¹, Bambang Agus Herlambang², Vetriselvan Subramaniyan³

¹Faculty of Health Sciences, Universitas Dian Nuswantoro, St. Imam Bonjol No. 207 Semarang, Central Java 50131, Indonesia

²Faculty of Engineering and Informatics, Universitas PGRI Semarang, Jl. Sidodadi-Timur No.24 Semarang, Central Java 50232, Indonesia

³Faculty of Medical and Life Science, Sunway University, Jl. Universiti No.5, Bandar Sunway (Petaling Jaya) 47500, Selangor Darul Ehsan, Malaysia

*vilda.setyawati@dsn.dinus.ac.id

Abstract. Delays in reporting anthropometric data from integrated health posts (*Posyandu*) to community health centers (*Puskesmas*) remain a major challenge in Indonesia's nutrition surveillance system. Existing national applications, such as e-PPGBM and WHO AnthroPlus, are limited to Puskesmas users, restricting early stunting detection at the community level. This study aimed to develop and evaluate a toddler integrated nutrition information system (SI-GEMBUL) as an Android-based application to improve timeliness and accuracy of data reporting. This research employed the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model. Stakeholders included *Posyandu* cadres, nutrition officers, and system developers. The application's functionality was validated through Black-Box Testing, while user implementation involved 44 cadres across several *Posyandu* within the Halmahera Health Center area of Semarang. The SI-GEMBUL application was successfully developed with four core features: anthropometric data entry, automatic Z-score calculation based on WHO standards, stunting education modules, and direct data transfer to Puskesmas. Implementation demonstrated 100% functional validity and improved reporting timeliness from an average of one week to less than one day. SI-GEMBUL provides an effective, community-based digital solution to strengthen early detection of stunting.

Keywords: toddler, stunting, detection, nutritional status, cadre

(Received 2025-11-28, Revised 2026-04-29, Accepted 2026-08-06, Available Online by 2026-10-28)

1. Introduction

Stunting remains a major public health concern and one of the key indicators of undernutrition worldwide, with an estimated global prevalence of 22%. Indonesia is among the ten countries with the highest burden of stunting [1]. Since 2018, the Indonesian government has implemented specific and

sensitive interventions to accelerate stunting reduction [2]. At the community level, *Posyandu* (Integrated Health Posts) serve as the frontline of child health services, operated by volunteer health cadres who conduct monthly anthropometric measurements for toddlers and maternal health monitoring. However, the reporting of anthropometric data from *Posyandu* to community health centers (*Puskesmas*) is often delayed, and the feedback provided to caregivers remains limited to simple weight charts recorded in the Maternal and Child Health (MCH) handbook [3]. According to WHO standards, nutritional status is determined using Z-scores derived from weight, height, sex, and age [4]. However, most *Posyandu* cadres and mothers are not familiar with these calculations, leading to delays in identifying growth faltering and initiating early stunting prevention [5]. A preliminary survey in several *Posyandu* revealed that most cadres had limited knowledge of stunting and relied on manual data entry using paper-based registers, which were later summarized and submitted monthly to the *Puskesmas* [6]. Furthermore, few studies quantitatively evaluate the impact of such systems on reporting timeliness and data accuracy in primary health settings.

Digital technology has been increasingly utilized to address health and nutrition challenges. Numerous smartphone-based applications have been developed to support child feeding practices, nutrition education, and parental guidance [7]. However, most of these tools focus on menu planning or dietary tracking without specific features for stunting detection or nutritional assessment. For example, the Children's Diet (CADE) application in Brazil measures food intake but lacks recommendations for nutrient adequacy or individualized dietary guidance [8], [9].

Several initiatives in Indonesia have also explored digital platforms for nutrition education and stunting prevention. For instance, a *Smart Village* for nutrition counselling and stunting education was developed in Sragen, and a mobile education application was tested in Semarang [10], [11]. However, these applications primarily focused on educational content and did not include features for anthropometric data reporting. Existing government applications, such as WHO AnthroPlus and e-PPGBM, also have limitations in accessibility and usability. WHO AnthroPlus is computer-based and presents only Z-score values without clear interpretation for non-professional users, while e-PPGBM can be accessed only by nutrition officers at the *Puskesmas* or district level [12], [13]. Both systems face challenges in data transmission speed, limited accessibility during working hours, and lack of decision-support features for timely intervention [14], [15].

This study contributes by integrating real-time anthropometric calculation, automated Z-score interpretation, and direct reporting into a single mobile platform evaluated through a structured development model (ADDIE). To address these gaps, this study developed a Toddler Integrated Nutrition Information System (SI-GEMBUL), a mobile-based application designed for *Posyandu* cadres and mothers to record, analyze, and report anthropometric data in real-time. The system aims to support early detection of stunting and facilitate faster integration with existing national nutrition databases. This study aimed to develop and quantitatively evaluate the effectiveness of SI-GEMBUL in improving reporting timeliness and usability among *Posyandu* cadres.

2. Methods

This study employed a Research and Development (R&D) design using the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model [15] [16] to develop and evaluate SI-GEMBUL, an Android-based nutrition information system. User needs were identified through FGDs, followed by system design and development integrating anthropometric data entry, automated WHO Z-score calculation, nutritional status assessment, and real-time reporting. Implementation involved 44 purposively selected *Posyandu* cadres in the Halmahera Health Center area, as a pilot project in the Semarang Municipal Health Office area.

Variables and Measurement

This study evaluated the SI-GEMBUL application using three key variables: reporting timeliness, system usability, and functional validity.

1. System usability

System usability referred to the ease of use, clarity of interface, and perceived usefulness of the SI-GEMBUL application among users (*Posyandu* cadres). This variable was measured using user feedback collected during the implementation phase. User responses were categorized into several

dimensions adapted from technology acceptance constructs. Qualitative feedback (suggestions to simplify data entry and improve readability) was used to complement the quantitative findings and identify areas for system improvement.

2. Functional validity

Functional validity refers to the degree to which the system's features operate according to predefined specifications. This variable evaluates whether the SI-GEMBUL application performs correctly in processing inputs and generating expected outputs. Measurement was conducted using Black-Box Testing, which assesses system functionality based on input-output verification without examining internal code structure. Testing included multiple scenarios representing core system features, such as login authentication, data input (mother and toddler data), anthropometric calculation (Z-score output), educational content access, and data export and reporting. Each test case was evaluated by comparing the expected output with the actual system output. Results were classified as valid (output matches expected result) or invalid (output does not match expected result). A higher percentage indicates greater system reliability. In this study, all test cases were classified as valid, indicating optimal functional performance of the application.

2.1 Ethical clearance

This study was conducted in accordance with ethical research standards and has been approved by the Health Research Ethics Committee of the Faculty of Health Sciences, Universitas Dian Nuswantoro (Ref. No. **164/EA/KEPK-Fkes-UDINUS/II/2022**). All participants provided informed consent prior to data collection.

3. Results and Discussion

3.1 Analysis

The needs analysis identified delayed reporting, duplicate data recording, and limited feedback as the main challenges in the existing Posyandu system. FGD findings indicated that anthropometric data required up to 7 days to reach the Puskesmas, while cadres experienced difficulties interpreting nutritional status due to the absence of automated Z-score calculations. These findings informed the development of SI-GEMBUL to integrate anthropometric data entry, automated analysis, and real-time reporting.

Table 1. FGD participants, problems, and features of SI-GEMBUL

Institution	n	Need/problem	Features in SI-GEMBUL that overcome
Semarang Public Health Office	3 (research and development team, nutrition officer)	Data arrives late every month	Excel data recap from the Puskesmas
Puskesmas	2 nutrition officers	Data arrives late every month	Excel data recap from the Posyandu
Semarang Posyandu Forum (FORPOS)	1 (leader)	FORPOS was capable of providing briefings but unable to provide solutions to data problems	Posyandu cadres can use SI-GEMBUL for data problems and also assistance in carrying out Posyandu
Cadres of Posyandu Rejosari	3 persons	Posyandu cadres are often overwhelmed with reporting data due to the many manual reports that must be done. The cadres have yet to receive feedback on the results of these measurements because the program holders who analyzed them were stunting status, nutritional status, and chronic energy deficiency to be reported to the health office.	<ul style="list-style-type: none"> - Cadres can input data into SI-GEMBUL, which will be automatically reported to the nutrition program holder - Cadres receive feedback on nutrition problems in children in their working area - Cadres have a recap of data files, so if there is an institution that needs the data, cadres only need to submit it without having to record it manually again

Posyandu cadres are responsible for the Puskesmas and the population control service for reporting

family planning (KB) program data. The conventional Posyandu system required cadres to record data during service activities and prepare separate monthly reports for the Puskesmas, resulting in duplicate recording and reporting delays.

3.2 Design

Based on the identified needs, the SI-GEMBUL system was designed as an Android-based application integrating anthropometric data entry, automated WHO Z-score calculation, and real-time integration with the Puskesmas dashboard. The system included three user roles: Posyandu cadres, mothers of toddlers, and nutrition officers, with workflows covering authentication, data entry, automated nutritional assessment, and reporting. Detailed UML and activity diagrams are provided in the supplementary file.

3.3 Development

The development phase successfully translated the system design into a functional Android-based application. The SI-GEMBUL interface was developed to support end users, particularly Posyandu cadres and mothers of toddlers, through a simplified and user-friendly layout. Figure 1 illustrates the main interface and core features of the application.



Figure 1. User Interface of SI-GEMBUL

The application consists of four primary features: (1) data input for mothers and toddlers, (2) stunting calculation, (3) educational materials, and (4) examination results. Users are required to register using an active email account before accessing the system, ensuring secure data management and user identification. The stunting calculation feature enables users to input key anthropometric variables, including body weight, height or length, mid-upper arm circumference, head circumference, date of birth, date of measurement, sex, and breastfeeding status. The system automatically calculates the Z-score based on WHO Child Growth Standards and presents the child's nutritional status along with tailored feedback. The automated process allows immediate classification and supports early identification of stunting [20]. In addition to Height/Length for Age (HAZ/LAZ), the system also calculates Weight for Age (WAZ) indicators to provide a more comprehensive assessment of child nutritional status. The integration of these indicators enables users to distinguish between underweight, stunting, and normal growth conditions. The educational feature provides accessible information on the causes, consequences, and prevention of stunting. This feature supports cadres in delivering nutrition counselling and includes recommendations for follow-up actions, such as referral to nutrition officers when abnormal growth is detected. Overall, the development phase resulted in an integrated application that combines data entry, automated nutritional assessment, and educational support within a single platform, enhancing both functionality and usability in community-based health services.

3.4 Implementation

Following a structured training session, cadres applied the SI-GEMBUL application during routine Posyandu activities to record and process anthropometric data. The input data consisted of maternal and toddler information collected during regular Posyandu sessions. The system generated outputs in the form of anthropometric indicators, including HAZ, WAZ, and WHZ. For example, a HAZ value of -3.56 SD indicates severe stunting. These outputs provide actionable information that supports cadres

and mothers in determining appropriate follow-up interventions. The implementation of SI-GEMBUL significantly improved reporting timeliness. Under the previous manual system, data reporting required approximately 7 days, whereas with SI-GEMBUL, reporting time was reduced to less than 1 day, representing an estimated $\geq 85\%$ reduction in reporting delay. This improvement demonstrates the system's effectiveness in accelerating data flow from Posyandu to Puskesmas. All data entered through the application are automatically compiled into a centralized dashboard managed by Puskesmas nutrition officers. The dashboard enables real-time access to anthropometric data, eliminating the need for manual data re-entry and improving data accuracy and accessibility across administrative levels. Figure 2 illustrates the dashboard interface used by administrators to monitor and manage SI-GEMBUL data. Previously, nutrition officers were required to manually re-enter data from paper-based registers into Excel. With SI-GEMBUL, data from each Posyandu can now be accessed and monitored directly through the system, enhancing efficiency and reducing potential data entry errors.

Figure 2 presents the system's administrative interface. A total of 37 Puskesmas in Semarang City have been integrated into the SI-GEMBUL system (Figure 2A). When a specific health center is selected, the system automatically displays data corresponding to Posyandu within its service area. Figure 2B shows the Posyandu-level data, which can be dynamically added or modified based on stakeholder needs. In addition, the application includes an educational feature that provides information on stunting definition, prevention, and management, as well as recommended nutrition practices. This feature supports cadres in delivering counseling, although access is limited to viewing without content modification. Overall, the implementation demonstrates that SI-GEMBUL not only facilitates real-time anthropometric assessment but also strengthens data integration and decision-making processes at the primary healthcare level.

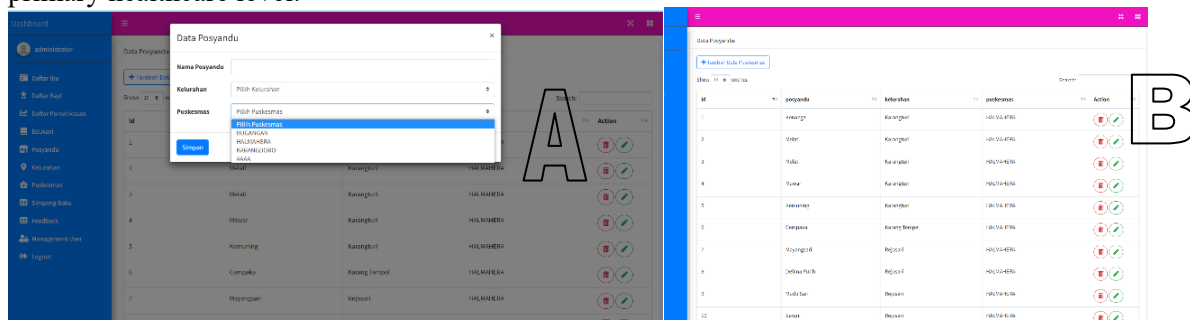


Figure 2. A. Dashboard page of Puskesmas; B. Posyandu page in admin dashboard

3.5 Functional Validity and Usability

As part of the evaluation stage within the ADDIE framework, the performance of the SI-GEMBUL application was assessed through functional validity testing and usability evaluation. These assessments aim to ensure that the system operates according to its design specifications and is acceptable for end users in real-world settings. Functional validity testing of the SI-GEMBUL application was conducted using Black-Box Testing, and the results are in **the supplementary file**. A total of 17 scenarios, including login authentication, data input, anthropometric calculation, and reporting features, were evaluated. All test cases were classified as valid (100%), indicating that system functions operated according to their intended design without technical errors.

During the login testing phase, no system failures were identified. However, at the beginning of the implementation workshop, several Posyandu cadres encountered difficulties due to the absence of active email accounts, which temporarily hindered the registration process. This issue was resolved during the training session and did not affect overall system functionality. Further testing on application features (Supplementary file) confirmed that all core functionalities, including data entry, stunting calculation, educational access, and report generation, performed as expected. These results demonstrate a high level of functional reliability of the SI-GEMBUL system. In addition to functional testing, usability evaluation was conducted through user feedback collected during the implementation workshop. Overall, cadres reported that the application was easy to use, clear, and relevant to their daily tasks. Minor suggestions included simplifying data entry steps and improving text readability on smaller screens. Quantitatively, user acceptance based on UTAUT2 constructs showed positive responses, including 83.3% for effort expectancy, 75% for behavioral intention to use, 66.7% for hedonic motivation, and 58.3% for performance expectancy. These findings indicate that SI-GEMBUL is not only functionally reliable but also acceptable and usable for community-based users.

The results of functional validity and usability evaluation confirm that SI-GEMBUL meets both technical and user-centered requirements identified during the analysis phase. This supports its feasibility for implementation in routine Posyandu activities and its potential to enhance digital transformation in primary healthcare services.

The findings of this study demonstrate that SI-GEMBUL effectively addresses key challenges in the conventional Posyandu reporting system, particularly delays in anthropometric data reporting, limited data accessibility, and lack of analytical support. The significant reduction in reporting time ($\geq 85\%$) indicates a substantial improvement in efficiency, supporting faster decision-making in community-based nutrition surveillance. These findings are consistent with previous studies highlighting the role of digital health applications in improving data management and service delivery in primary healthcare settings [3]. However, unlike prior applications that primarily focus on dietary assessment or educational content [8], [9], SI-GEMBUL integrates real-time data entry, automated Z-score analysis, and direct reporting to health facilities. This integrated approach strengthens its contribution to community-level nutrition monitoring.

The results of functional validity testing showed that all system features operated as intended (100% valid), indicating that SI-GEMBUL meets its technical design specifications. In addition, usability evaluation demonstrated positive user acceptance, which aligns with previous findings using the UTAUT2 model, where the majority of cadres expressed favorable perceptions of system usefulness and ease of use [21]. Similar evaluations have also been applied in digital health and mobile application studies, including food-related applications [22], confirming that user acceptance is a critical factor in system sustainability. From a public health perspective, SI-GEMBUL supports early detection of stunting through automated anthropometric analysis. Early detection is essential, particularly during the first 1000 days of life, which is a critical period for preventing long-term growth and developmental impairments [23]. Unlike predictive models used in other studies [24], SI-GEMBUL provides direct and immediate classification based on WHO growth standards, enabling timely identification and intervention.

The importance of early detection is further supported by longitudinal evidence showing that untreated stunting can lead to persistent growth deficits, reduced cognitive performance, and long-term

health consequences [25], [26]. In Indonesia, where Posyandu cadres play a central role in community-based health services, strengthening their capacity through digital tools is essential, especially considering their voluntary status and limited technical training [27]. SI-GEMBUL also offers practical advantages by providing real-time feedback based on anthropometric measurements, allowing cadres and caregivers to take appropriate follow-up actions. The simplicity of the system design is a key factor supporting its usability and sustainability, as users tend to prefer applications that are efficient and easy to operate [28].

However, this study has limitations. The implementation was conducted in a single health center area with a relatively small sample size, which may limit the generalizability of the findings. In addition, the system is currently limited to the Android platform and supports only one language. Future development should consider web-based integration and multi-language support to expand accessibility. Future research is recommended to evaluate large-scale implementation, integration with national health information systems, and the long-term impact of SI-GEMBUL on stunting reduction outcomes.

4. Conclusion

This study developed and evaluated the SI-GEMBUL application using the ADDIE model to improve anthropometric data reporting at the community level. The findings demonstrate that SI-GEMBUL effectively addresses delays in reporting from Posyandu to Puskesmas by enabling real-time data entry and automated nutritional status analysis. Implementation results showed a substantial improvement in reporting timeliness ($\geq 85\%$ reduction), while functional testing confirmed that all system features operated reliably (100% valid). In addition, usability evaluation indicated positive user acceptance among Posyandu cadres.

Overall, SI-GEMBUL provides a feasible and effective digital solution for integrating anthropometric data reporting and supporting early detection of stunting. The system has strong potential for broader implementation to strengthen community-based nutrition surveillance and decision-making.

Declaration of AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used Claude AI and Grammarly in order to improve the language and readability of the manuscript. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We would like to express our sincere gratitude to Universitas Dian Nuswantoro, respondents and all parties. We also thank Professor Siti Nurmaina, who has provided input in assisting the international scientific article writing training held by the Ministry of Education, Culture, Research, and Technology.

References

- [1] A. K. Manggala, K. W. M. Kenwa, M. M. L. Kenwa, A. A. G. D. P. J. Sakti, and A. A. S. Sawitri, "Risk factors of stunting in children aged 24-59 months," *Paediatr. Indones.*, vol. 58, no. 5, pp. 205–12, 2018, doi: <https://doi.org/10.14238/pi58.5.2018.205-12>.
- [2] WHO, *Reducing stunting in children: equity considerations for achieving the Global Nutrition Targets 2025*. 2018. [Online]. Available: <https://www.who.int/publications/i/item/9789241513647%0A> Accessed on 18th February 2022
- [3] F. R. Rinawan *et al.*, "Understanding mobile application development and implementation for monitoring Posyandu data in Indonesia: a 3-year hybrid action study to build 'a bridge' from the

- community to the national scale.,” *BMC Public Health*, vol. 21, no. 1, p. 1024, May 2021, doi: <https://doi.org/10.1186/s12889-021-11035-w>.
- [4] S. D. Meilinda, A. Utami, - Yulianto, and A. Cahyaningtias, “Posyandu During the COVID-19 Pandemic: Diversification and Participation,” *J. Sumbangsih*, vol. 1, no. 1, pp. 167–175, 2020, doi: <https://doi.org/10.23960/jsh.v1i1.61>.
- [5] R. A. D. Mardani, K. Wetasin, and W. Suwanwaiphatthana, “the Predicting Factors Affecting the Occurrence of Stunting in Children Under Five Years of Age,” *J. Kesehat. Masy.*, vol. 11, no. 1, p. 1, 2015, doi: <https://doi.org/10.15294/kemas.v11i1.3927>.
- [6] K. K. R. Indonesia, *Regulation of The Minister of Health of The Republic Indonesia*, vol. 7, no. 2. 2020, pp. 33–48. [Online]. Available: <http://repository.radenintan.ac.id/11375/1/PERPUSPUSAT.pdf%0Ahttp://business-law.binus.ac.id/2015/10/08/pariwisata-syariah/%0Ahttps://www.ptonline.com/articles/how-to-get-better-mfi-results%0Ahttps://journal.uir.ac.id/index.php/kiat/article/view/8839>
- [7] R. Srivastava, S. Kushwaha, P. Khanna, M. Gupta, B. Bharti, and R. Jain, “Comprehensive overview of smartphone applications delivering child nutrition information,” *Nutrition*, vol. 103–104, p. 111773, 2022, doi: <https://doi.org/10.1016/j.nut.2022.111773>.
- [8] T. M. Garvin *et al.*, “Cooking Matters Mobile Application: a meal planning and preparation tool for low-income parents,” *Public Health Nutr.*, vol. 22, no. 12, pp. 2220–2227, Aug. 2019, doi: <https://doi.org/10.1017/S1368980019001101>.
- [9] J. V. Freitas, S. P. Crispim, and M. C. Araujo, “Development of a mobile application to assess Brazilian schoolchildren’s diet: CADE - food consumption at home and at school,” *J. Nutr. Sci.*, vol. 11, p. e27, 2022, doi: <https://doi.org/10.1017/jns.2022.25>.
- [10] M. I. Alhari, W. Febriyani, W. T. Jonson, and A. A. N. Fajrillah, “Designing a Smart Village Educational Application Platform for Stunting Alleviation and Monitoring the Health of Pregnant Women,” *J. Ilm. Teknol. Inf. Asia*, vol. 15, no. 1, p. 51, 2021, doi: <https://doi.org/10.32815/jitika.v15i1.562>.
- [11] A. Satriatmi, S. P. Jati, A. Suryoputro, and E. Y. Fatmasari, “Stakeholder Mapping Analysis on the Scaling-Up Nutrition Movement during the 1000 Days of Life between the Urban and Rural Government Areas,” *Unnes J. Public Heal.*, vol. 10, no. 1, pp. 68–77, 2021, doi: <https://doi.org/10.15294/ujph.v10i1.38029>.
- [12] S. Anjani, F. D. P. Anggraini, V. A. V. Setyawati, A. Aprianti, and A. N. Indriati, “The Effectiveness of Mobile Edu App-Based Educational Methods as an Intervention Program to Reduce Stunting with the Nurture, Love, and Stimulation Approach,” *J. Eduscience*, vol. 9, no. 1, pp. 143–151, 2022, doi: <https://doi.org/10.36987/jes.v9i1.2559>.
- [13] S. A. Prabhu, N. K. Shukla, and S. R. Mandala, “Assessment of Nutritional Status of Rural Children (0-18 years) in Central India Using World Health Organization (WHO) Child Growth Standards 2007’.”, *Indian J. community Med. Off. Publ. Indian Assoc. Prev. Soc. Med.*, vol. 45, no. 3, pp. 323–327, 2020, doi: https://doi.org/10.4103/ijcm.IJCM_348_19.
- [14] L. Prapkree, M. Sadjadi, F. Huffman, and C. Palacios, “Development and pilot testing of the snackability smartphone application to identify healthy and unhealthy snacks,” *Healthc. Inform. Res.*, vol. 25, no. 3, pp. 161–172, 2019, doi: <https://doi.org/10.4258/hir.2019.25.3.161>.
- [15] L. Prapkree, C. Palacios, M. Sadjadi, and F. Huffman, “Development and Pilot Testing of the Snackability Smartphone Application to Identify Healthy and Unhealthy Snacks (P04-185-19),” *Curr. Dev. Nutr.*, vol. 3, p. 3131833, 2019, doi: <https://doi.org/10.1093/cdn/nzz051.p04-185-19>.
- [16] R. Munoo and R. Abdullah, “Chapter 27 - Adding ADDIE to the Library Orientation Program at Singapore Management University Libraries,” K. Bailin, B. Jahre, and S. B. T.-P. L. O. Morris, Eds., Chandos Publishing, 2018, pp. 263–271. doi: <https://doi.org/10.1016/B978-0-08-102171-2.00027-1>.
- [17] P. W. Rob Pooley, *Applying UML, Advanced Application*, !!St. Edinburgh: Heriot-Watt University, 2003.
- [18] M. Siebenhaller and M. Kaufmann, “Drawing activity diagrams,” *Proc. - SOFTVIS 06 ACM*

- Symp. Softw. Vis.*, pp. 159–160, 2006, doi: <https://doi.org/10.1145/1148493.1148523>.
- [19] R. A. Latif and M. Z. M. Nor, “Using the addie model to develop a rusnani concept mapping guideline for nursing students,” *Malaysian J. Med. Sci.*, vol. 27, no. 6, pp. 115–127, 2020, doi: <https://doi.org/10.21315/mjms2020.27.6.11>.
 - [20] R. I. Mentri Kesehatan, “Regulation of the Minister of Health of the Republic of Indonesia Number 2 of 2020 concerning Child Anthropometric Standards,” *Menteri Kesehat. Republik Indones.*, vol. 2507, no. February, pp. 1–78, 2020.
 - [21] M. N. Santi, R. Nurmandhani, V. A. V. Setyawati, E. Rimawati, A. Wardoyo, and M. Iqbal, “Penerapan Model Utaut 2 Untuk Mengetahui Minat Penggunaan Aplikasi Si-Gembul Pada Kader Posyandu Di Puskesmas Halmahera Semarang,” *VISIQUES J. Kesehat. Masy.*, vol. 21, no. 2, 2022, doi: <https://doi.org/10.33633/visiques.v21i2supp.6675>.
 - [22] L. D. Zanetta *et al.*, “The use of food delivery apps during the COVID-19 pandemic in Brazil: The role of solidarity, perceived risk, and regional aspects.,” *Food Res. Int.*, vol. 149, p. 110671, Nov. 2021, doi: <https://doi.org/10.1016/j.foodres.2021.110671>.
 - [23] J. Gausman, R. Kim, and S. V. Subramanian, “Stunting trajectories from post-infancy to adolescence in Ethiopia, India, Peru, and Vietnam.,” *Matern. Child Nutr.*, vol. 15, no. 4, p. e12835, Oct. 2019, doi: <https://doi.org/10.1111/mcn.12835>.
 - [24] J. Castro-Bedriñana, D. Chirinos-Peinado, and G. De La Cruz-Calderón, “Predictive model of stunting in the Central Andean region of Peru based on socioeconomic and agri-food determinants.,” *Public Heal. Pract. (Oxford, England)*, vol. 2, p. 100112, Nov. 2021, doi: <https://doi.org/10.1016/j.puhip.2021.100112>.
 - [25] A. Deshpande and R. Ramachandran, “Early childhood stunting and later life outcomes: A longitudinal analysis.,” *Econ. Hum. Biol.*, vol. 44, p. 101099, Jan. 2022, doi: <https://doi.org/10.1016/j.ehb.2021.101099>.
 - [26] C. Scheffler, B. Bogin, and M. Hermanussen, “Catch-up growth is a better indicator of undernutrition than thresholds for stunting.,” *Public Health Nutr.*, vol. 24, no. 1, pp. 52–61, Jan. 2021, doi: <https://doi.org/10.1017/S1368980020003067>.
 - [27] H. Khoeroh, O. W. K. Handayani, and D. R. Indriyanti, “Evaluasi Penatalaksanaan Gizi Balita Stunting Di Wilayah Kerja Puskesmas Sirampog,” *Unnes J. Public Heal.*, vol. 6, no. 3, p. 189, 2017, doi: <https://doi.org/10.15294/ujph.v6i3.11723>.
 - [28] H. Schumer, C. Amadi, and A. Joshi, “Evaluating the dietary and nutritional apps in the google play store,” *Healthc. Inform. Res.*, vol. 24, no. 1, pp. 38–45, 2018, doi: <https://doi.org/10.4258/hir.2018.24.1.38>.