# Design and Evaluation of a User-Centered Mobile Application for Elderly Activity Monitoring with Conceptual IoT-Based Emergency Response System

**Peter[1], Yana Erlyana[2*]**

[1,2]Faculty of Technology and Design, Universitas Bunda Mulia, North Jakarta, DKI Jakarta, Indonesia
E-mail: [1]petergan74@gmail.com, [2*]yerlyana@bundamulia.ac.id

(Received: 21 Jul 2025, revised: 11 Aug 2025, accepted: 22 Aug 2025)

**Abstract**

Elderly individuals living independently face increasing safety risks, including medication non-compliance and delayed emergency responses. This study presents the design and evaluation of a user-centered mobile application for elderly activity monitoring supported by a conceptual Internet of Things (IoT)-based emergency response system. The User-Centered Design (UCD) method was applied through five structured phases: empathize, define, ideate, prototype, and test. The design process incorporated survey data from 100 respondents and expert interviews to determine user needs. Key features include medication reminders, emergency buttons, automated alerts, and proposed integration with CCTV for remote monitoring. A system flow diagram was developed to illustrate the conceptual architecture for data communication between users and caregivers. The UI/UX prototype was created using Figma, prioritizing accessibility through high-contrast visuals, enlarged text, and simplified navigation tailored to elderly users. Usability testing using the system usability scale (sus) yielded an average score of 82, indicating excellent perceived usability. These results demonstrate the potential of combining UCD principles with a conceptual IoT framework to enhance home safety for elderly users through responsive mobile technology.

**Keywords:** Elderly Monitoring, User-Centered Design, Mobile Application, Emergency Response System, IoT Framework

## I. INTRODUCTION

The increasing global elderly population presents a significant challenge for healthcare systems, family structures, and community-based care services. According to projections by the World Health Organization (WHO), the number of individuals aged 60 years or older is expected to reach 1.4 billion by 2030 [1]. This demographic transition indicates a growing demand for assistive technologies to support independent elderly living, especially in regions where caregiving resources are limited. In Indonesia, the elderly population continues to rise annually, accompanied by an increase in chronic health conditions and age-related vulnerabilities such as cognitive decline, vision or hearing loss, and reduced mobility [2]. These factors significantly heighten the risk of medical emergencies occurring within the home environment, particularly when elders are left unattended for extended periods [3].

Recent technological advancements in Information and Communication Technology (ICT) offer new opportunities to address elderly care challenges through mobile applications and smart monitoring systems [4], [5]. Mobile-based health (mHealth) applications have been widely adopted to promote wellness, track health indicators, and assist users in managing medical conditions [6], [7]. However, many existing applications are primarily focused on data logging and monitoring vital signs without incorporating features tailored to the specific behavioral and cognitive needs of elderly users [8]. Moreover, these applications often lack real-time responsiveness, intuitive interface design, or seamless integration with alert mechanisms that are critical during emergency situations [9], [10]. As a result, elderly individuals may experience difficulties in navigation or misinterpret important information, leading to delayed actions or noncompliance with prescribed medical routines.

In addition, many elderly monitoring applications are designed from a technical standpoint, with limited emphasis on human-centered principles such as ease of use, emotional comfort, or accessibility [9]. For example, interface layouts may involve small font sizes, low contrast colors, or overly complex menu hierarchies that do not align with the perceptual and motor limitations of aging users. Therefore, it is essential to bridge the gap between engineering functionality and user experience by adopting design

DOI: 10.34148/teknika.v14i3.1336

CC BY SA

approaches that center on the real needs and capabilities of the elderly population [9].

This study proposes the design and evaluation of a user-centered mobile application for elderly activity monitoring, supported by a conceptual Internet of Things (IoT)-based emergency response system [11]. The application aims to provide essential functions such as medication reminders, emergency buttons, automated alert generation, and a visual-based monitoring interface that can be integrated with closed-circuit television (CCTV) feeds. The system is conceptualized to allow caregivers or family members to receive real-time updates and respond promptly to emergencies triggered within the application.

The design methodology adopted in this study is based on the User-Centered Design (UCD) framework, which involves five iterative phases: empathize, define, ideate, prototype, and test [12], [13], [14], [15]. In the initial phases, elderly users and caregivers were surveyed and interviewed to gather insight into their daily routines, technological literacy, and preferences for interaction [16]. These insights were used to develop low-fidelity and high-fidelity prototypes through Figma, with a strong focus on interface clarity, contrast, typography size, and simplicity of interaction. The system concept was further elaborated using system flow diagrams and wireframes to illustrate how user actions would translate into alerts, notifications, or log entries, potentially connected to external IoT devices in future implementations [17], [18].

Usability testing was conducted to evaluate the effectiveness of the design and the degree to which it met user expectations. The System Usability Scale (SUS) was employed to measure perceived usability [19], [20], and the prototype achieved a score of 82, indicating a high level of acceptance and ease of use. This result supports the feasibility of integrating UCD principles with a conceptual IoT framework to enhance the safety, comfort, and independence of elderly individuals within their own homes.

In summary, this research contributes to the development of responsive and accessible mobile technologies in the domain of elderly care. By prioritizing both interface usability and system responsiveness, the proposed application presents a scalable foundation for future development involving real-time sensor integration and advanced alert mechanisms using IoT-based platforms.

## II. RESEARCH METHODOLGY

This study applied a structured User-Centered Design (UCD) methodology to develop a mobile application prototype for elderly activity monitoring, supported by a conceptual Internet of Things (IoT) based emergency response system [21], [22]. The UCD approach ensures that the resulting interface and functionality are closely aligned with the needs, limitations, and daily routines of elderly users and their caregivers [23], [24]. The research methodology consisted of five phases: empathize, define, ideate, prototype, and test [16].

In the empathize phase, primary data were collected through a structured online questionnaire involving 100 respondents, including family members, caregivers, and individuals who live with or assist elderly people. The survey explored common home safety risks, technology use habits, and user preferences related to activity monitoring and emergency response. Additionally, in-depth interviews were conducted with two professional UI/UX designers and two healthcare practitioners specializing in geriatric care to gather expert insights. These qualitative findings were validated through triangulation, comparing input across different respondent types and professions to improve objectivity and reliability [25].

During the define phase, the insights from the empathize stage were synthesized to generate user personas and key user requirements. The design objectives were determined based on recurring patterns found in the survey and interview responses. The essential requirements included a simple user interface with clear visual elements, accessible features such as large buttons and readable fonts, a reliable and quick-trigger emergency alert system, and proposed integration with external monitoring tools such as CCTV.

The ideate phase focused on translating these user needs into concrete interface design concepts. Low-fidelity wireframes were sketched to define layout structures and screen flows. Brainstorming and comparative analysis of existing mobile applications in the health-tech and elderly care domains helped benchmark potential design directions [26]. Key functional modules were identified, including medication reminders, emergency button activation, activity logs, and caregiver notifications.

In the prototype phase, a high-fidelity interface prototype was developed using Figma, a collaborative interface design tool [27]. The UI/UX design emphasized accessibility for elderly users by applying high-contrast color palettes, large-scale typography, and reduced cognitive load per interaction. A conceptual system flow diagram was also developed to visualize the interaction between the user, the mobile application, and external caregivers through a proposed IoT-based communication architecture [28]. This diagram represents the logical sequence from user actions, such as activating the emergency button, to the transmission of data and real-time notifications sent to caregivers. Figure 1 illustrates the system workflow and proposed IoT integration for emergency monitoring.

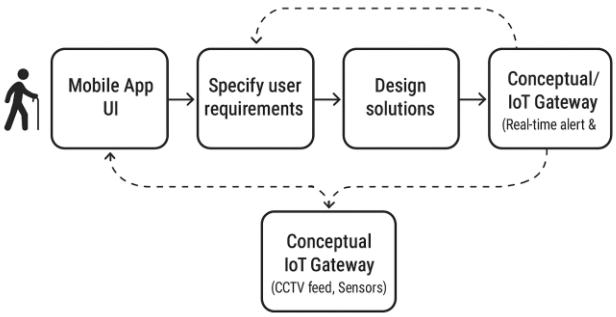



Figure 1. The System Workflow and IoT Integration


DOI: 10.34148/teknika.v14i3.1336

In the final test phase, usability testing was conducted with five individuals representing family caregivers of elderly users. Each participant completed predefined tasks that simulated real-world usage of the main application features. Usability performance was measured using the System Usability Scale (SUS), a standardized instrument for evaluating user experience [16], [29]. The average SUS score recorded was 82, which is categorized as excellent, indicating high user satisfaction and functional clarity of the prototype.

This methodology not only established a responsive and elderly-friendly design process but also provided a conceptual foundation for future development in IoT-based mobile healthcare systems [30], [31]. The combined use of UCD principles, mobile application prototyping, and conceptual sensor-based system design contributes directly to the fields of human-computer interaction and information and communication technology [28].

## III. RESULT AND DISCUSSION

The results of this study reflect the iterative design and evaluation process of a user-centered mobile application tailored for elderly activity monitoring, supported by a conceptual Internet of Things (IoT)-based emergency response system. Following the five phases of the User-Centered Design (UCD) methodology [32], [33], the development process involved identifying user needs, specifying requirements, producing design solutions, prototyping and evaluation, and implementation and validation. Table 1 summarizes the activities, outputs, and findings at each UCD stage.

Table 1. UCD Stages, Activities, and Outputs in Application Development

| UCD Stage | Activities Performed | Outputs/Findings |
|---|---|---|
| **1. Understanding and Specifying the Context of Use** | Conducted surveys with elderly individuals; interviewed healthcare professionals and UI/UX experts to identify needs, challenges, and usage context. | Identified critical concerns: safety, independence, and ease of use for elderly living alone. |
| **2. Specifying User and Organizational Requirements** | Prioritized functional requirements based on collected data. | Four key features defined: (1) medication reminders, (2) emergency button, (3) automated caregiver notifications, (4) conceptual integration of CCTV/sensor monitoring. |
| **3. Producing Design Solutions** | Created low-fidelity wireframes and information architecture diagrams focusing on accessibility. | Visual representation of navigation flow, feature placement, large buttons, and high-contrast design. |
| **4. Prototyping and Evaluation** | Developed interactive prototypes; conducted usability testing with elderly users and caregivers; gathered feedback. | Improved UI with simpler menu labels, increased font size, and single-step emergency activation. |
| **5. Implementation and Validation** | Built functional mobile application prototype; conceptualized IoT-based emergency response integration; conducted SUS testing. | High SUS score indicating good usability; validated application as acceptable and easy to use. |

The early visual structure of the application was translated into wireframes to guide navigation and task flows [34]. The low-fidelity wireframes were used for preliminary feedback from target users and caregivers, focusing on layout structure and ease of understanding [35]. These were later refined into high-fidelity prototypes developed in Figma, incorporating high-contrast colors, large tap areas, and minimalist design principles tailored for elderly users. This evolution is illustrated in Figure 2, 3, 4, which displays the progression from mid fidelity wireframes, high fidelity wireframe to a polished UI interface.

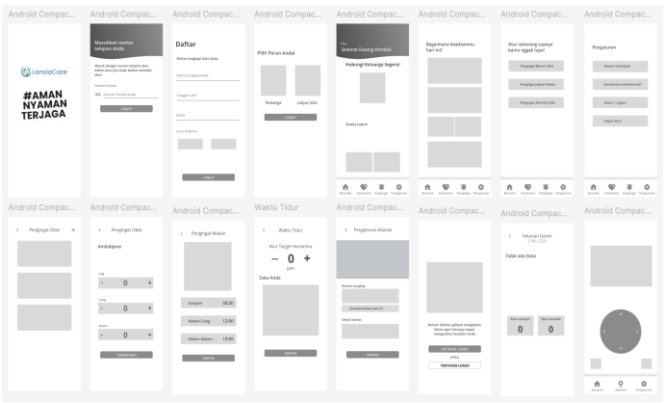



Figure 2. Mid-fidelity Prototype Mobile Version

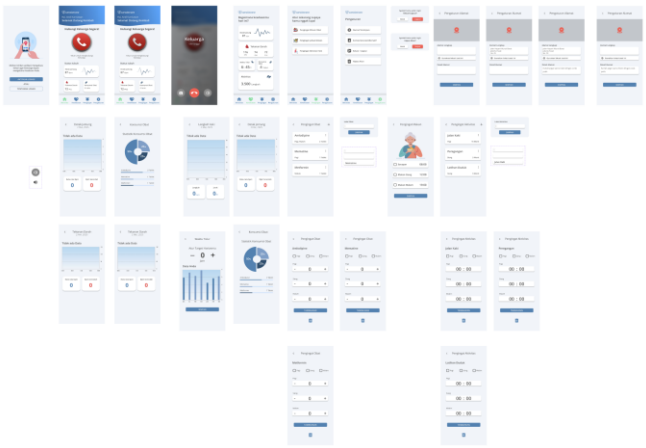


Figure 3. High-fidelity Prototype Mobile Version

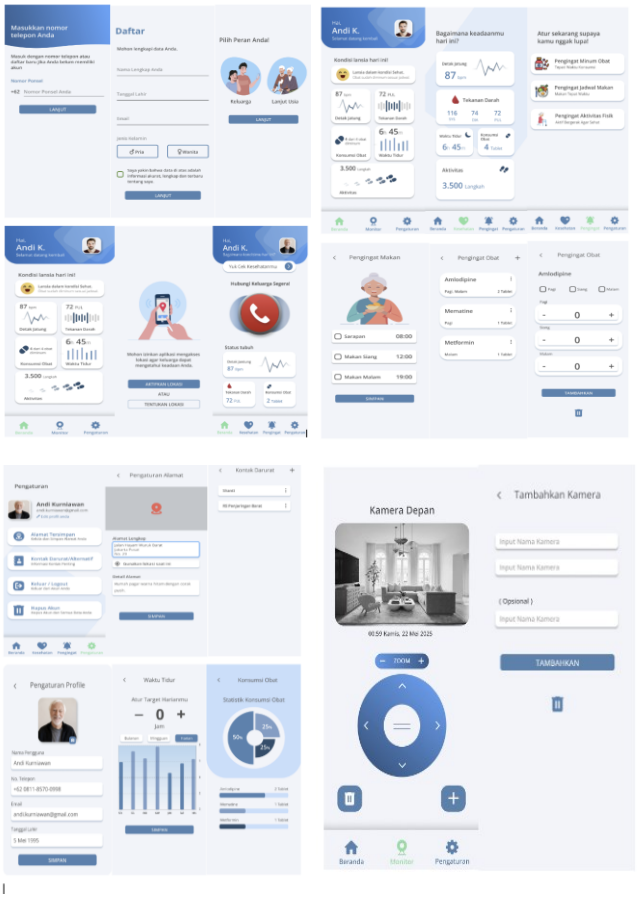


Figure 4. The Prototype of UI Design

The finalized interface includes screens for onboarding, emergency interaction, reminder setup, and caregiver dashboards. This layout reflects UCD principles by ensuring every visual element has clear functional purpose, avoiding clutter, and optimizing readability for aging eyes. User feedback during the wireframing stage guided refinements in navigation sequence, icon placement, and response time clarity. To assess usability, five caregivers representing the app's target user group were invited for task-based testing. Participants completed key interactions such as triggering emergency alerts, adjusting reminder settings, and viewing caregiver-linked information. Upon completing these tasks, they responded to the System Usability Scale (SUS) questionnaire, a standardized evaluation tool widely adopted for ICT product testing [29]. The app received an average SUS score of 82 out of 100, which is categorized as "Excellent" in usability benchmarks.

Detailed SUS item scores are presented in Table 2. Most participants reported high confidence and ease of learning, affirming the success of the simplified UI design. Slightly lower scores on consistency and perceived complexity highlight typical challenges when adapting digital tools for older populations, though the scores remained within acceptable limits.

Table 2. Average System Usability Scale (SUS) Scores for Each Questionnaire Item

| SUS Item | Mean Score (out of 5) |
|---|---|
| I think I would use this system frequently | 04.06 |
| I found the system unnecessarily complex | 02.00 |
| I thought the system was easy to use | 04.08 |
| I think I would need help to use it | 02.02 |
| I found the functions well integrated | 04.04 |
| I found inconsistency in the system | 02.06 |
| I think most people can learn quickly | 04.06 |
| I found it cumbersome to use | 02.00 |
| I felt confident using the system | 04.08 |
| I needed to learn many things before using the app | 02.04 |

Overall, these findings validate the user-centered approach adopted in this study. Design elements informed by real user input can significantly enhance usability outcomes, particularly in mobile technology tailored to the elderly population. In addition, a comprehensive application flowchart was developed to visualize the interaction paths between elderly users and their family caregivers. This flow structure supports clarity in navigation, reduces interface complexity, and optimizes the distribution of functionality across different user roles.

The results illustrate how integrating UCD methodology with a conceptual IoT framework can produce a mobile application that is not only technically robust but also sensitive to the contextual needs of elderly users. Although the IoT integration remains conceptual in this phase, the proposed architecture and visual interface design anticipate future implementation of real-time sensor data such as fall detection or home environment monitoring. These features will further improve the safety and responsiveness of elderly care systems.

## IV. CONCLUSION

This study presents the design and evaluation of a user-centered mobile application aimed at enhancing the safety and


DOI: 10.34148/teknika.v14i3.1336

independence of elderly individuals living alone through activity monitoring and a conceptual Internet of Things (IoT)-based emergency response framework. Utilizing the User-Centered Design (UCD) methodology, the development process involved structured phases including user research, ideation, prototyping, and testing, resulting in four prioritized features: medication reminders, emergency alert buttons, caregiver notifications, and a proposed integration with environmental sensors or CCTV systems.

The application interface was designed using Figma with accessibility in mind, incorporating high-contrast visuals, simplified navigation, and large interactive elements tailored to elderly users. To validate usability, five caregivers participated in task-based testing followed by the System Usability Scale (SUS) assessment. The application received an average SUS score of 82 out of 100, indicating excellent perceived usability according to standardized benchmarks in ICT product evaluation.

Although the IoT emergency response system remains at the conceptual stage, a system flow architecture was developed to illustrate its potential integration in future iterations. This framework anticipates the use of sensor data and real-time alerts to enhance caregiving responsiveness and situational awareness.

The findings of this study reinforce the significance of user-centered principles in designing mobile technologies for aging populations, particularly in health and safety contexts. Future research may focus on implementing the IoT components in a functional prototype and expanding user testing across diverse demographics. Ultimately, this work contributes to the advancement of inclusive digital health solutions by demonstrating how thoughtful design and conceptual IoT integration can support aging-in-place strategies in an increasingly connected society.

## REFERENCES


[1] H. Mandala Putra, 'Alimuddin, Suhartini, and Wahyu Rizki, "Pengembangan Sistem untuk Deteksi dan Identifikasi Lokasi Kecelakaan pada Lansia sebagai Bentuk Peningkatan Keselamatan berbasis Internet of Things (IoT)," *Infotek: Jurnal Informatika dan Teknologi*, vol. 8, no. 1, pp. 205–216, Jan. 2025, doi: 10.29408/jit.v8i1.28263.

[2] R. W. Basrowi, E. M. Rahayu, L. C. Khoe, E. Wasito, and T. Sundjaya, "The road to healthy ageing: What has indonesia achieved so far?," Oct. 01, 2021, *MDPI*. doi: 10.3390/nu13103441.

[3] B. Supudomkul, D. Jareemit, P. Khanchaitit, and T. Janjamlha, "A Readiness of Areas and Space Planning in Houses Supporting Emergency Services for Fall Injuries in the Elderly," in *IOP Conference Series: Materials Science and Engineering*, IOP Publishing Ltd, Sep. 2020. doi: 10.1088/1757-899X/910/1/012017.

[4] C. R. Cunha, V. Mendonça, E. P. Morais, J. Fernandes, and I. Letra, "Using mobile devices and apps to assist the elder population in rural areas and generate business opportunities," *IBIMA Business Review*, vol. 2020, Dec. 2020, doi: 10.5171/2020.585068.

[5] K. S. Wijaya and J. G. Amanda, "Perancangan dan Implementasi Security dan Sistem Kendali Otomatis Smart Home Menggunakan Nodemcu," *Jurnal Algoritma, Logika dan Komputasi*, vol. VI, no. 1, pp. 543–552, Mar. 2023, doi: 10.30813/j-alu.v2i2.3756.

[6] S. Abbaspur-Behbahani, E. Monaghesh, A. Hajizadeh, and S. Fehresti, "Application of mobile health to support the elderly during the COVID-19 outbreak: A systematic review," Mar. 01, 2022, *Elsevier B.V.* doi: 10.1016/j.hlpt.2022.100595.

[7] J. L. Hennessy and A. Rodrigues, "Economic impacts of changing technologies on New Zealand homecare delivery," *J Enabling Technol*, vol. ahead-of-print, no. ahead-of-print, Aug. 2019, doi: 10.1108/JET-11-2018-0055.

[8] C. Del-Valle-Soto, R. A. Briseño, L. J. Valdivia, R. Velázquez, and J. A. Nolazco-Flores, "Non-Invasive Monitoring of Vital Signs for the Elderly Using Low-Cost Wireless Sensor Networks: Exploring the Impact on Sleep and Home Security," *Future Internet*, vol. 15, no. 9, p. 287, Aug. 2023, doi: 10.3390/fi15090287.

[9] N. Liu, J. Yin, S. S.-L. Tan, K. Y. Ngiam, and H. H. Teo, "Mobile health applications for older adults: a systematic review of interface and persuasive feature design," *Journal of the American Medical Informatics Association*, vol. 28, no. 11, pp. 2483–2501, Oct. 2021, doi: 10.1093/jamia/ocab151.

[10] M. Jingar, H. Lindgren, and M. Blusi, "Exploring Limitations of User Interface Design to Understanding the Gap Between Technology and Seniors," 2021. doi: 10.3233/SHTI210315.

[11] P. Chyan, "Automatic monitoring system for the elderly based on internet of things," *IOP Conf Ser Mater Sci Eng*, vol. 1088, no. 1, p. 012041, Feb. 2021, doi: 10.1088/1757-899x/1088/1/012041.

[12] A. M. Ali, A. Khamaj, Z. Kang, M. Moosa, and M. M. Alam, "User-Centered Design (UCD) of Time-Critical Weather Alert Application," *International Journal of Advanced Computer Science and Applications*, vol. 14, no. 1, p. 2023, 2023, doi: 10.14569/IJACSA.2023.0140188.

[13] N. Hiu and Y. Erlyana, "Redesigning User Interface of Datascripmall Mobile Apps Using User Centered Design Method," *Teknika*, vol. 13, no. 2, pp. 283–292, Jul. 2024, doi: 10.34148/teknika.v13i2.854.

[14] R. W. Saputri, M. E. Prasetyo, and Y. Erlyana, "Designing smart applications as a solution for e-service of hydroponics product in the digital era," in *International Conference on Industrial, Enterprise, and System Engineering: Collaboration of Science, Technology, and Innovation Toward Sustainable Development*, Jakarta: AIP Publishing, Nov. 2023, p. 020010. doi: 10.1063/5.0120567.

[15] M. Chandra and Y. Erlyana, "Pilah sampah melalui media edukasi kreatif: pendekatan design thinking,"

*Jurnal Desain*, vol. 12, no. 3, p. 811, Jul. 2025, doi: 10.30998/jd.v12i3.24282.

[16] C. Moral, R. Pérez-Rodríguez, E. Villalba-Mora, J. Barrio-Cortes, X. Ferre, and L. Rodríguez-Mañas, "Integrated health system to assess and manage frailty in community dwelling: Co-design and usability evaluation," *Digit Health*, vol. 9, Jan. 2023, doi: 10.1177/20552076231181229.

[17] S. Aisyah *et al.*, "Designing an IoT Agriculture Monitoring System for Improving Farmer's Acceptance of … Designing an IoT Agriculture Monitoring System for Improving Farmer's Acceptance of Using IoT Technology," 2022. [Online]. Available: www.etasr.com

[18] F. Ehrler and K. Blondon, "Conception and Development of a Targeted Alert System: Multisystem Considerations," 2023. doi: 10.3233/SHTI230102.

[19] H. Firdaus and A. Zakiah, "Implementation of usability testing methods to measure the usability aspect of management information system mobile application (Case study sukamiskin correctional institution)," *International Journal of Modern Education and Computer Science*, vol. 13, no. 5, pp. 58–67, 2021, doi: 10.5815/ijmecs.2021.05.06.

[20] P. D. Tremoulet, "Clinical decision support for intervention reduction in neonatal patients: A usability assessment," *Digit Health*, vol. 8, 2022, doi: 10.1177/20552076221113696.

[21] K. Intawong, W. Boonchieng, P. Lerttrakarnnon, E. Boonchieng, and K. Puritat, "A-SA SOS: A Mobile- and IoT-based Pre-hospital Emergency Service for the Elderly and Village Health Volunteers," *International Journal of Advanced Computer Science and Applications*, vol. 12, no. 4, p. 2021, 2021, doi: 10.14569/IJACSA.2021.0120465.

[22] L. S, M. M, S. R, and S. V, "IoT Based Ambulance Alert System for Geriatric people," *Int J Eng Adv Technol*, vol. 10, no. 5, pp. 48–52, Jun. 2021, doi: 10.35940/ijeat.e2589.0610521.

[23] C. Panagopoulos, A. Menychtas, P. Tsanakas, and I. Maglogiannis, "Increasing Usability of Homecare Applications for Older Adults: A Case Study," *Designs (Basel)*, vol. 3, no. 2, p. 23, May 2019, doi: 10.3390/designs3020023.

[24] C. M. Timon *et al.*, "Developing Independent Living Support for Older Adults Using Internet of Things and AI-Based Systems: Co-Design Study," *JMIR Aging*, vol. 7, pp. e54210–e54210, Oct. 2024, doi: 10.2196/54210.

[25] R. B. Ohnson and L. B. Christensen, *Educational Research: Quantitative, Qualitative, and Mixed Approaches*, 7th ed. California: SAGE Publications, Inc, 2020.

[26] V. B. R. Bhimanapati, P. K. G. Pandian, and P. Goel, "UI/UX Design Principles for Mobile Health Applications," *International Journal for Research Publication and Seminar*, vol. 15, no. 3, pp. 216–231, Aug. 2024, doi: 10.36676/jrps.v15.i3.1485.

[27] S. Lersilp, S. Putthinoi, P. Lerttrakarnnon, and P. Silsupadol, "Development and Usability Testing of an Emergency Alert Device for Elderly People and People with Disabilities," *Scientific World Journal*, vol. 2020, 2020, doi: 10.1155/2020/5102849.

[28] M. Alrizq, S. A. Solangi, A. Alghamdi, M. A. Nizamani, M. A. Memon, and M. Hamdi, "An architecture supporting intelligent mobile healthcare using human-computer interaction HCI principles," *Computer Systems Science and Engineering*, vol. 40, no. 2, pp. 557–569, Sep. 2021, doi: 10.32604/CSSE.2022.018800.

[29] C. C. Quinn, S. Staub, E. Barr, and A. Gruber-Baldini, "Mobile support for older adults and their caregivers: Dyad usability study," *JMIR Aging*, vol. 2, no. 1, Jan. 2019, doi: 10.2196/12276.

[30] S. Zhang and J. Song, "An empirical investigation into the preferences of the elderly for user interface design in personal electronic health record systems," *Front Digit Health*, vol. 5, 2023, doi: 10.3389/fdgth.2023.1289904.

[31] T. P. T. Armand, M. A. I. Mozumder, S. Ali, A. O. Amaechi, and H.-C. Kim, "Developing a Low-Cost IoT-Based Remote Cardiovascular Patient Monitoring System in Cameroon," *Healthcare*, vol. 11, no. 2, p. 199, Jan. 2023, doi: 10.3390/healthcare11020199.

[32] G. L. Diaz Intal, D. Senoro, and T. Palaoag, "User Experience Design for Disaster Management Mobile Application using Design Thinking Approach," in *2020 The 4th International Conference on Software and e-Business*, New York, NY, USA: ACM, Dec. 2020, pp. 7–13. doi: 10.1145/3446569.3446587.

[33] W. Baswardono, Y. Septiana, D. M. Arifin, and D. D. S. Fatimah, "Design of emergency response assessment system using Feature-Driven Development approach," *IOP Conf Ser Mater Sci Eng*, vol. 1098, no. 3, p. 032072, Mar. 2021, doi: 10.1088/1757-899x/1098/3/032072.

[34] Jannatunnisa, A. Rahim, and Sayekti Harits Suryawan, "Optimizing UI/UX of AIMsCORE Application with Design Thinking to Enhance User Interaction and Engagement," *Teknika*, vol. 14, no. 2, pp. 205–212, Jul. 2025, doi: 10.34148/teknika.v14i2.1213.

[35] Q. Li and Y. Luximon, "Older adults' use of mobile device: usability challenges while navigating various interfaces," *Behaviour & Information Technology*, vol. 39, no. 8, pp. 837–861, Aug. 2020, doi: 10.1080/0144929X.2019.1622786.