International Journal of Electrical and Computer Engineering (IJECE)
Vol. 14, No. 3, June 2024, pp. 3036~3044
ISSN: 2088-8708, DOI: 10.11591/ijece.v14i3.pp3036-3044

Transforming clinical clerkship processes with integrated information systems

Hery Dian Septama[1], Lukmanul Hakim[1], Meizano Ardhi Muhammad[1], Fidha Rahmayani[2], Dwi Indria Anggraini[3], Siska Lania[4], Robert Bestak[5]
[1]Department of Electrical Engineering and Informatics, University of Lampung, Bandar Lampung, Indonesia
[2]Department of Neurology, Faculty of Medicine, University of Lampung, Bandar Lampung, Indonesia
[3]Department of Dermatology and Venereology, Faculty of Medicine, University of Lampung, Bandar Lampung, Indonesia
[4]Department of Education and Training, Abdul Moeloek General Hospital, Bandar Lampung, Indonesia
[5]Department of Telecommunication, Czech Technical University in Prague, Prague, Czech Republic

Article Info

Article history:

Received Nov 23, 2023
Revised Mar 3, 2024
Accepted Mar 5, 2024

Keywords:

Clinical clerkship
Extreme programming
Integrated system
Medical education
User experience questionnaire

ABSTRACT

There are still many manual administrative processes involved in clinical clerkships. However, digital technologies and software solutions can significantly improve medical education. This paper aims to utilize extreme programming (XP) as a methodology for developing the information system. A total of 23 user stories have been planned for completion. The priority of each requirement stated in the user stories is determined using the MoSCoW prioritization technique. The results indicate that the software successfully passed all tests among the 23 black box testing scenarios. Developing an integrated information system to streamline clinical clerkships has been successfully achieved. The user experience questionnaire (UEQ) is utilized to gather the perspectives of hospital management and medical faculty members regarding the information system. The average scores for each category are as follows: 1.93 for attractiveness, 2.04 for perspicuity, 2.20 for efficiency, 2.06 for dependability, 2.14 for stimulation, and 1.85 for novelty. Therefore, it can be concluded that all existing user experience scales exhibit an outstanding degree of user satisfaction.

Corresponding Author:

Hery Dian Septama
Department of Electrical Engineering and Informatics, University of Lampung
35145 Bandar Lampung, Indonesia
Email: hery@eng.unila.ac.id

1. INTRODUCTION

Becoming a medical doctor requires a comprehensive education covering theoretical knowledge and practical application. Medical education is unique as it includes clinical clerkships, which integrate real-world medical practice into the learning journey. This phase is a crucial aspect of the curriculum for aspiring medical professionals [1]. The medical education curriculum includes two phases: preclinical (four years) and clinical (two years). To obtain a medical doctor's license, medical school graduates must complete a two-year clinical clerkship before taking the national exam [2]. The clinical clerkship phase is completed through rotations across 13 clinical stages. These activities are conducted with the expert guidance and meticulous supervision of esteemed teaching staff at teaching hospitals [3]. These guiding principles ensure the educational process aligns with the community's needs [4]. The ultimate objective of medical education is to develop competent and qualified medical doctors who can provide health services that meet national standards. However, despite its importance, many administrative processes related to clinical clerkship are still handled manually. The use of conventional paper-based systems has its benefits, but they also have

drawbacks that hinder the progress of the educational process [5]. The current method of managing clinical clerkship rotations involves a lot of paperwork and manual tasks for administrators, students, and lecturers. This process is time-consuming and prone to errors, which can negatively impact the outcomes. Therefore, adopting a more innovative and efficient approach is crucial to transforming how clinical clerkship rotations are planned and executed [6]. The persistence of manual administrative methods in rapidly advancing digital technologies highlights a significant gap in adopting information and communication technology (ICT) solutions in medical education. This gap is particularly notable in a global context where digital transformation reshapes healthcare delivery and education, suggesting a pressing need for research and innovation in managing clinical clerkships.

The rapid development of digital technologies and software solutions holds great promise for a brighter future [7]. Hospitals and institutions can increase overall efficiency by optimizing administrative processes, reducing the likelihood of mistakes, and switching from manual paperwork to a digital platform [8]. Currently, advancements in information and communication technology are indispensable in all fields, including medical or hospital [9]–[14]. Utilizing information technology can also facilitate the learning process for the medical profession study program [15]–[17]. Especially during the coronavirus disease (COVID-19) pandemic, a lot of research has been conducted to evaluate the novel learning process by using information technology [18]–[20]. Quality progress in the learning process must result in positive changes, such as motivated students who actively engage in the learning process and achieve excellent learning outcomes [21]. Students' motivation and life skills will rise due to technology-assisted skill acquisition, and instructors will find it easier to create learning materials [22]. The medical education of doctors involves a complex and multifaceted learning process that can benefit from an integrated information system. This system can be composed of numerous modules or subsystems whose data can be merged [23]–[25].

From the literature reviewed, there is a notable scarcity of discussions on leveraging ICT to enhance the learning processes for medical doctors, particularly during the clinical clerkship stage. Instead, ICT utilization has predominantly focused on hospital management practices, encompassing patient management, financial operations, and archival procedures. Our research proposes developing and implementing an integrated information system for administering clinical clerkships to address this gap. This system aims to modernize the management of clerkships by replacing manual, paper-based processes with a digital platform that enhances administrative efficiency, reduces errors, and improves access to information for all stakeholders. A clinical clerkship education information system is a software platform designed to support the education of medical students during their clinical rotations [26]–[28]. This integrated information system will replace the paper-based method used during clinical clerkship. It is also essential to consider the challenges of transitioning from a paper-based system to an electronic system, including the need for specialized training, the cost of technology and equipment, and the potential for technical problems [29], [30]. This study aims to design and develop an integrated information system for the clinical clerkship process during medical education while evaluating faculty members' and students' experiences.

2. METHOD

This paper aims to utilize extreme programming (XP) as a methodology for developing the information system [31]. XP is an agile software development methodology that follows a structured approach [32]. It consists of several distinct phases, each of which plays a crucial role in the overall success of the methodology depicted in Figure 1. XP's software development consists of exploration, planning, release iterations, production, and maintenance phases.

The exploration phase establishes the foundation for the project, while the planning phase constructs a plan that adapts to the constantly evolving nature of software development. Iterations to release enable continuous testing, validation, and adaptation, ensuring the software remains closely aligned with the customers' needs. During the production phase, the software undergoes iterations that result in its evolution into a more comprehensive and robust system. Finally, the maintenance phase emphasizes maintenance and evolution based on user feedback. The final stage is the death phase, which encourages a careful evaluation of the project's accomplishments and areas that require improvement, enabling valuable insights to be utilized in future endeavors. The strength of XP lies in its adaptability and ability to accommodate changing requirements at any stage of development. This adaptability is the key to its success in projects characterized by evolving needs and dynamic environments.

The final step is to acquire the perspectives of students and faculty members regarding the novel integrated information system for clinical clerkship that needs to be evaluated [33]. The user experience questionnaire (UEQ) is a standardized tool used to measure and assess the user experience with a product or service [34]. The UEQ typically consists of questions related to different aspects of the user experience, such as ease of use, satisfaction, and overall impression. The responses to these questions are used to generate scores and provide insights into the strengths and weaknesses of the product or service. The UEQ can be used

to gather feedback from users, identify areas for improvement, and optimize the user experience over time [35]–[37]. Six scales representing the most essential user experience (UX) features for a more extensive selection of items came from the empirical creation of the questionnaire. The UEQ questionnaire was administered to respondents selected using a form of purposive sampling. Respondents in this study were students and faculty members who were users of integrated clinical clerkship information systems. To fulfill the study's primary objectives, namely the user experience evaluation, the user must utilize the information system at least once. According to the UEQ manual, at least 20 to 30 respondents are required to provide accurate results [38]. This research used 30 participants, including 18 students and 12 faculty members, who completed a 26-question questionnaire with seven answer options. Values from the UEQ statements were transformed by reducing each datum by four. Cronbach's alpha test evaluated the UEQ [39].

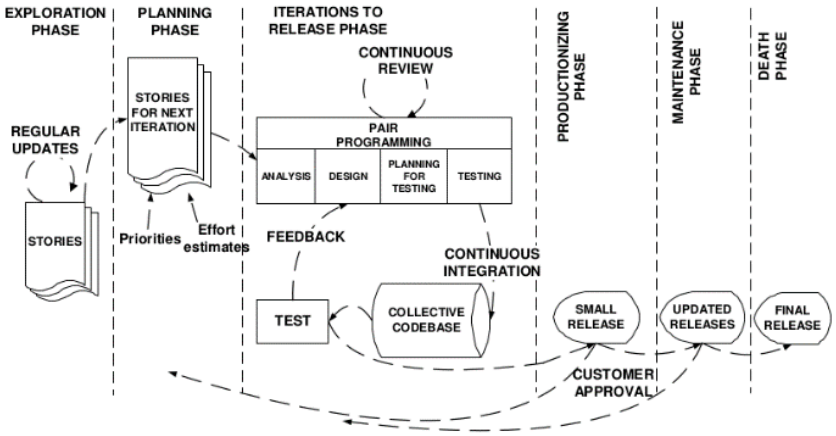

Figure 1. The extreme programming (XP) methodology [40]

3. RESULTS AND DISCUSSION

3.1. Exploration phase

The exploration phase in XP is critical to developing a clinical clerkship information system. It has two objectives: to investigate current business processes and to develop user stories. The team aims to comprehend clinical clerkship processes at Abdul Moeloek General Hospital and identify strengths, weaknesses, and areas for improvement. User stories describe functionalities, features, and interactions and anticipate end-users requirements. Although the system was initially designed for the University of Lampung, its design can be utilized in other universities, particularly in Indonesia. The exploration phase is crucial in establishing the groundwork for the following stages of development in the extreme programming method. Its primary objective is to guarantee that the system fulfills its users' requirements and expectations. The proposed integrated information system for clinical clerkship consists of several modules, i.e., lecture and student, attendance, clinical rotation, scheduling, stages, grades, and graduation. Figure 2 shows the main modules of developing an integrated clinical clerkship information system. The integrated data will make it easy to create a dashboard or business intelligence tool to monitor students' performance, schedule, supply, and other relevant information.

3.2. Planning phase

During the planning stage, the team creates a project plan that includes timelines, deliverables, and resource allocation. They use nominal scale prioritization mechanisms to categorize requirements into different groups based on their level of importance [41]. The MoSCoW prioritization technique helps determine the priority of user stories [42]. A focus group discussion is organized with the hospital management and academic staff to evaluate and rank the relative importance of the user stories. This collaborative exercise helps gather valuable insights into individuals' preferences and perspectives on information system features. The prioritization process results in 21 must-have and two could-have priorities from the 23 user stories currently in existence. The team estimated labor hours for each user story using the narrative point sizing method [43]. One-point equals eight hours of work. Based on 23 requirements, 59 points were assigned, ranging from 1 to 7 points. The project is estimated to require 59 working days or approximately 472 hours to complete. Each user story will be processed individually, and the developed features will only be approved by the customer when satisfied.

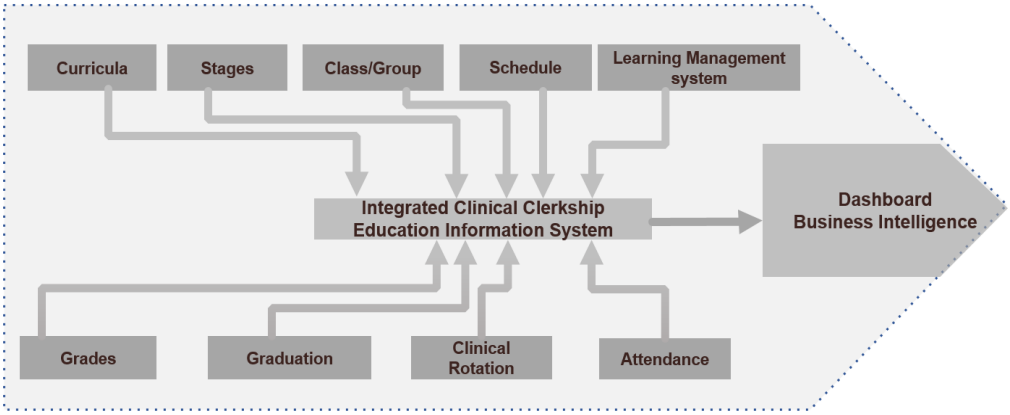

Figure 2. Integrated clinical clerkship information system module

3.3. Iteration phase

The concept of iterations lies at the core of XP. These iterations are short development cycles designed to deliver functional increments of software. These iterations have three crucial phases: design, coding, and testing. During the design phase, the development team works together to design the structure and architecture of the software increment that will be built. This phase is characterized by close collaboration with stakeholders, including end-users, to ensure a clear understanding of the requirements. The focus is on simplicity, which allows for minimal design documentation. Instead, the focus is on just-in-time design, which involves creating only what is necessary for the current iteration. The code phase entails the practical execution of the software increment. Developers collaborate to write, review, and integrate code collectively. One of the defining characteristics of XP is pair programming. This practice encourages the sharing of knowledge, problem-solving, and the improvement of code quality. The code increments are expected to be simple, straightforward, and functional while adhering to the design created during the previous phase. Testing is an essential component of XP and is conducted consistently throughout development. Figure 3 illustrates the implementation of the clinical rotation group feature. The automatic group creation and rotation features are crucial in simplifying the intricate process of assigning and rotating student groups during clinical clerkship.

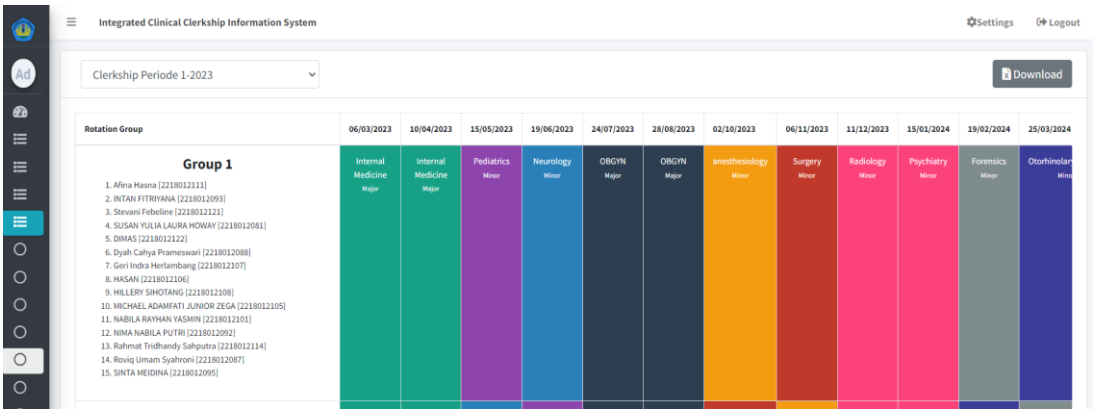

Figure 3. User interface for clinical rotation group implementation

These features significantly reduce the administrative workload for educators and save valuable time. This allows them to focus on delivering high-quality education instead of getting entangled in the complexities of group management. Furthermore, this application provides a useful attendance recap feature, an invaluable tool for educators. The system compiles and presents a comprehensive summary of student attendance statistics. This feature enables instructors to monitor and evaluate attendance patterns efficiently, detect possible concerns, and implement proactive measures to maintain a consistent and interactive learning

environment. This feature enhances the teaching experience and facilitates data-driven decision-making, ultimately improving educational outcomes. The black-box testing approach plays a pivotal role in ensuring the quality and reliability of the application. This method utilizes the capabilities of a black box to thoroughly examine the application from the user's point of view, accurately representing real-life situations. It is a robust methodology designed to evaluate the system's functionality by exposing it to external stimuli that simulate potential scenarios in which software failures could occur. The main focus here is on the input provided to the software and the resulting output that it generates, ensuring that it is in line with the end-user experience. The results indicate that out of the 23 testing scenarios, the software passed all of the tests.

3.4. Production phase

The production phase in XP represents the final stage of the software development process. During this phase, the emphasis transitions from code creation to the deployment and maintenance of the software. The process encompasses conducting final testing, deploying the system, and ensuring ongoing maintenance and improvement. XP places a strong emphasis on customer collaboration, even in this particular phase. The main objective is to guarantee that the software effectively fulfills the needs and expectations of the users. The user experience questionnaire (UEQ) assesses user satisfaction with the developed information system. To determine the dependability of each scale, a Cronbach alpha calculation is performed on the mean correlation, which displays the result value of each correlation divided by the number of related statements on the UEQ scale. According to Cronbach alpha calculations, all scales, including those for attractiveness (0.78), perspicuity (0.76), efficiency (0.88), dependability (0.70), stimulation (0.86), and novelty (0.84), are more significant than 0.70 (the minimum degree of Cronbach's alpha reliability).

The research aimed to take an additional step by comparing the test results with benchmark data established by the UEQ. The results of this comparative analysis are visually depicted in Figure 4, enabling a clear and concise interpretation of the outcomes about their position and significance. The benchmark statistics displayed in Figure 4 indicate that all user experience scales are positive. According to the UEQ manual, a number is considered positive if greater than 0.8. The average scores for each category are as follows: 1.93 for attractiveness, 2.04 for perspicuity, 2.20 for efficiency, 2.06 for dependability, 2.14 for stimulation, and 1.85 for novelty. Therefore, all user experience scales are already at an excellent level. However, some experience scales need to be reviewed to enhance the user experience as part of the subsequent design enhancement. According to the benchmark result, attractiveness and novelty have lower scores. The low score on the novelty scale can be interpreted as the fact that because most users use smartphone applications, they want a better novelty by developing a mobile version.

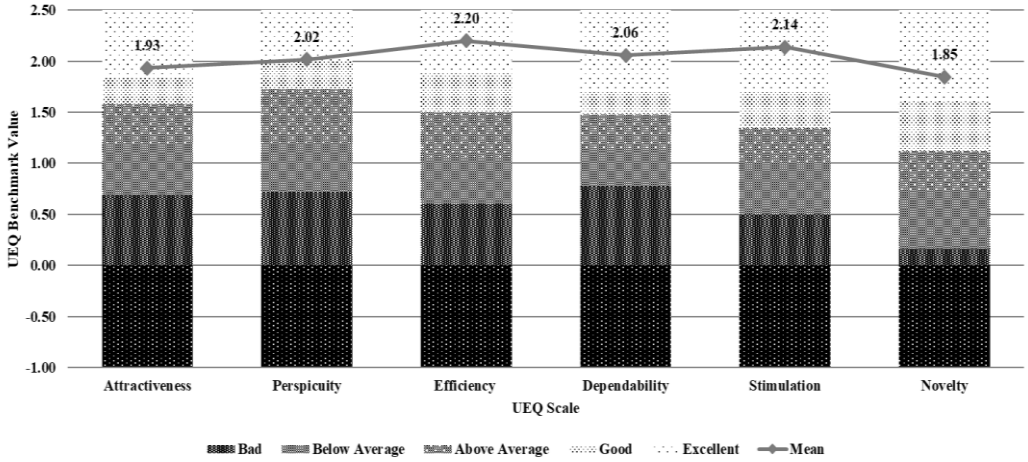

Figure 4. UEQ-determined benchmark diagram

The comprehensive study on developing an integrated information system for clinical clerkship management, utilizing the XP methodology, has resulted in a usable information system product. The study also addresses the inefficiencies of traditional, manual administrative processes in clinical clerkships by proposing a digital solution. This solution modernizes management practices, enhancing educational outcomes and organizational efficiency. The research findings demonstrate significant improvements in administrative processes and user satisfaction, as evidenced by positive UEQ scores across various metrics.

However, attractiveness and novelty were identified for further enhancement, suggesting mobile application development as a future direction. This study underscores the potential of digital transformation in medical education, offering a model for similar interventions in healthcare education globally. The scheduling process for clinical rotations, assessments, and other clinical clerkship activities, which typically require extensive time and are prone to errors, can now be completed more swiftly and accurately. These features benefit faculty, staff, and clinical clerkship students' educational processes. Furthermore, these capabilities can be further integrated with various information systems to develop dashboards or business intelligence tools. The implications of these findings suggest a move towards more agile, user-centered approaches in educational administration, with a focus on continuous improvement and adaptation to user needs.

4. CONCLUSION

Developing an integrated information system to streamline clinical clerkship has been successfully achieved. The features that have been successfully integrated include a curriculum module, stages, class/group, schedule, grades, attendance, clinical rotation, and the graduation process. During the focus group discussion, a total of 23 user stories were obtained and subsequently developed with success. The UEQ is utilized to collect the perspectives of hospital management and medical faculty members regarding the information system. The average scores for each category are as follows: 1.93 for attractiveness, 2.04 for perspicuity, 2.20 for efficiency, 2.06 for dependability, 2.14 for stimulation, and 1.85 for novelty. As a result, all user experience scales currently demonstrate exceptional user satisfaction. However, there is room for improvement in some regions of the experience scales to further enhance the overall user experience. The improvements above will be integrated into our future design enhancements. Based on the benchmark results, it is evident that the categories of attractiveness and novelty have received lower scores. The lower novelty score indicates there is a need for increased novelty. One potential way to achieve this is by developing a mobile version of the application, considering that most users utilize mobile applications.

ACKNOWLEDGEMENTS

We want to express our sincere appreciation to the Higher Education for Technology and Innovation (HETI) Project Unila for their support in funding this research through the Innovation and Domestic Collaboration Research Scheme for the year 2022. We also thank Abdul Moeloek General Hospital and the Faculty of Medicine at the University of Lampung for collaborating on this research project.

REFERENCES

[1] T. Dornan *et al.*, "How and what do medical students learn in clerkships? Experience based learning (ExBL)," *Advances in Health Sciences Education*, vol. 19, no. 5, pp. 721–749, Mar. 2014, doi: 10.1007/s10459-014-9501-0.

[2] R. Mustika, H. Nishigori, S. Ronokusumo, and A. Scherpbier, "The odyssey of medical education in Indonesia," *Asia Pacific Scholar*, vol. 4, no. 1, pp. 4–8, Jan. 2019, doi: 10.29060/TAPS.2019-4-1/GP1077.

[3] M. D. Jeff Wiese, S. Bent, and S. Saint, "Clinical clerkships: The answer book," Lippincott Williams and Wilkins, 2006, Accessed: Mar. 07, 2024. [Online]. Available: http://books.google.com.tw/books?id=pvK2JGMA9kgC

[4] D. P. Sari, Y. P. Susani, D. Suryani, and E. Amalia, "Students' experiences of interaction with the supervisors during the transition to clinical clerkships," *Jurnal Pendidikan Kedokteran Indonesia: The Indonesian Journal of Medical Education*, vol. 9, no. 2, Art. no. 138, Jul. 2020, doi: 10.22146/jpki.40749.

[5] D. M. Torre, R. Treat, S. Durning, and D. M. Elnicki, "Comparing PDA-and paper-based evaluation of the clinical skills of third-year students," *Wisconsin Medical Journal*, vol. 110, no. 1, pp. 9–13, Feb. 2011.

[6] P. L. Ghazali and S. R. Soleman, "Evaluation of the public health clinical rotation in medical school: a qualitative case study design," *Korean Journal of Medical Education*, vol. 35, no. 1, pp. 93–102, Mar. 2023, doi: 10.3946/kjme.2023.252.

[7] F. Sharaf and S. Alnohair, "Comparison of medical students' learning approaches between electronic and hard copy team-based learning.," *International Journal of Health Sciences*, vol. 11, no. 1, pp. 1–4, 2017, Accessed: Mar. 07, 2024. [Online]. Available: http://www.ncbi.nlm.nih.gov/pubmed/28293158%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC5327673

[8] F. M. Howard, C. A. Gao, and C. Sankey, "Implementation of an automated scheduling tool improves schedule quality and resident satisfaction," *PLoS ONE*, vol. 15, no. 8 August, Art. no. e0236952, Aug. 2020, doi: 10.1371/journal.pone.0236952.

[9] P. M. Neri *et al.*, "Emergency medicine resident physicians' perceptions of electronic documentation and workflow: A mixed methods study," *Applied Clinical Informatics*, vol. 6, no. 1, pp. 27–41, 2015, doi: 10.4338/ACI-2014-08-RA-0065.

[10] J. S. Ancker *et al.*, "Associations between healthcare quality and use of electronic health record functions in ambulatory care," *Journal of the American Medical Informatics Association*, vol. 22, no. 4, pp. 864–871, Apr. 2015, doi: 10.1093/jamia/ocv030.

[11] D. P. Manca and M. Greiver, "Do electronic medical records improve quality of care?," *Canadian Family Physician*, vol. 61, no. 10, p. 846, Oct. 2015.

[12] Y. Zaitin, M. Mansurova, M. Kunelbayev, G. Tyulepberdinova, T. Sarsembayeva, and A. Shomanov, "Development of a patient health monitoring system based on the internet of things with a module for predicting vital signs," *Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)*, vol. 33, no. 1, pp. 518–529, Jan. 2024, doi: 10.11591/ijeecs.v33.i1.pp518-529.

[13] R. Ganiga, R. M. Pai, M. M. Manohara Pai, and R. K. Sinha, "Security framework for cloud based electronic health record (EHR) system," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 10, no. 1, pp. 455–466, Feb. 2020, doi: 10.11591/ijece.v10i1.pp455-466.

[14] A. H. Eldeeb, A. M. Abdelsalam, A. M. Shehata, H. S. K. Ali, and S. Fouad, "Health monitoring of historic buildings using machine learning in real-time internet of things (IoT)," *Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)*, vol. 32, no. 2, pp. 725–733, Nov. 2023, doi: 10.11591/ijeecs.v32.i2.pp725-733.
[15] A. Rajaram, N. Patel, Z. Hickey, B. Wolfrom, and J. Newbigging, "Perspectives of undergraduate and graduate medical trainees on documenting clinical notes: Implications for medical education and informatics," *Health Informatics Journal*, vol. 28, no. 2, Art. no. 146045822210934, Jan. 2022, doi: 10.1177/14604582221093498.
[16] D. A. Raptis, C. Fernandes, W. Chua, and P. B. Boulos, "Electronic software significantly improves quality of handover in a London teaching hospital," *Health Informatics Journal*, vol. 15, no. 3, pp. 191–198, Aug. 2009, doi: 10.1177/1460458209337431.
[17] A. Kuek and S. Hakkennes, "Healthcare staff digital literacy levels and their attitudes towards information systems," *Health Informatics Journal*, vol. 26, no. 1, pp. 592–612, Apr. 2020, doi: 10.1177/1460458219839613.
[18] P. M. Lashley *et al.*, "Student satisfaction and self-efficacy in a novel online clinical clerkship curriculum delivered during the COVID-19 pandemic," *Advances in Medical Education and Practice*, vol. 13, pp. 1029–1038, Sep. 2022, doi: 10.2147/AMEP.S374133.
[19] A. B. Hassan, A. El-Agroudy, M. H. Shehata, M. A. Almoawda, and H. S. Atwa, "Adaptations of clinical teaching during the COVID-19 pandemic: Perspectives of medical students and faculty members," *Advances in Medical Education and Practice*, vol. 13, pp. 883–892, Aug. 2022, doi: 10.2147/AMEP.S371201.
[20] M. K. Alsmadi, "The students' acceptance of learning management systems in Saudi Arabian Universities," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 10, no. 4, pp. 4155–4161, Aug. 2020, doi: 10.11591/ijece.v10i4.pp4155-4161.
[21] K. Phodong, T. Supnithi, and R. Kongkachandra, "Development of computer-based learning system for learning behavior analytics," *Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)*, vol. 25, no. 1, pp. 460–473, Jan. 2022, doi: 10.11591/ijeecs.v25.i1.pp460-473.
[22] S. L. Leong, C. D. Baldwin, and A. M. Adelman, "Integrating web-based computer cases into a required clerkship: development and evaluation," *Academic Medicine*, vol. 78, no. 3, pp. 295–301, Mar. 2003, doi: 10.1097/00001888-200303000-00012.
[23] A. R. N. Malaya, E. A. Munar, F. P. Cuison, and E. G. Dacanay, "Information management system for research of Don Mariano Marcos Memorial State University–South La Union Campus," *Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)*, vol. 28, no. 3, pp. 1668–1675, Dec. 2022, doi: 10.11591/ijeecs.v28.i3.pp1668-1675.
[24] E. A. Q. Torres, W. A. L. Beltrán, and J. M. S. Céspedes, "Design of an environmental management information system for the Universidad Distrital," *Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)*, vol. 25, no. 1, pp. 529–539, Jan. 2022, doi: 10.11591/ijeecs.v25.i1.pp529-539.
[25] M. M. Amin, A. Sutrisman, D. Stiawan, Ermatita, M. Y. Alzahrani, and R. Budiarto, "Interoperability framework for integrated e-health services," *Bulletin of Electrical Engineering and Informatics (BEEI)*, vol. 9, no. 1, pp. 354–361, Feb. 2020, doi: 10.11591/eei.v9i1.1825.
[26] A. Alismail, B. M. Tabisula, and D. López, "Designing a clinical education tracking system: An innovative approach," *Advances in Medical Education and Practice*, vol. 12, pp. 539–546, May 2021, doi: 10.2147/AMEP.S312734.
[27] I. Masic *et al.*, "Information technologies (ITs) in medical education," *Acta Informatica Medica*, vol. 19, no. 3, Art. no. 161, 2011, doi: 10.5455/aim.2011.19.161-167.
[28] M. Bahadorani, J. J. Gardiner, A. Houshyari, R. Peña, M. Tootoonchi, and P. Adibi, "Medical education and information and communication technology," *Journal of Education and Health Promotion*, vol. 1, no. 1, 2012, doi: 10.4103/2277-9531.94411.
[29] S. Kumar and K. Aldrich, "Overcoming barriers to electronic medical record (EMR) implementation in the US healthcare system: A comparative study," *Health Informatics Journal*, vol. 16, no. 4, pp. 306–318, Dec. 2010, doi: 10.1177/1460458210380523.
[30] B. Talebi and N. Seyednazari, "Challenges of information systems in healthcare organizations," *Health Management & Information Science*, vol. 25, no. 2, pp. 58–66, 2019.
[31] C. Beck, K., and Andres, *Extreme programming explained: Embrace change (2nd ed.)*, vol. 2. Boston, MA: Addison-We, 2018.
[32] A. K. M. Z. Islam and D. A. Ferworn, "A comparison between agile and traditional software development methodologies," *Global Journal of Computer Science and Technology*, pp. 7–42, Dec. 2020, doi: 10.34257/gjcstcvol20is2pg7.
[33] A. Heshmati, N. Moftian, P. Rezaei-Hachesu, and T. Samad-Soltani, "Simple and efficient measurement of the user experience in health information systems: A persian version," *Iranian Journal of Public Health*, vol. 50, no. 1, pp. 217–218, Jan. 2021, doi: 10.18502/ijph.v50i1.5097.
[34] M. Schrepp, A. Hinderks, and J. Thomaschewski, "Construction of a benchmark for the user experience questionnaire (UEQ)," *International Journal of Interactive Multimedia and Artificial Intelligence*, vol. 4, no. 4, Art. no. 40, 2017, doi: 10.9781/ijimai.2017.445.
[35] A. Hinchliffe and W. K. Mummery, "Applying usability testing techniques to improve a health promotion website," *Health Promotion Journal of Australia*, vol. 19, no. 1, pp. 29–35, 2008, doi: 10.1071/he08029.
[36] M. A. Kushendriawan, H. B. Santoso, P. O. H. Putra, and M. Schrepp, "Evaluating user experience of a mobile health application 'Halodoc'' using user experience questionnaire and usability testing,'" *Jurnal Sistem Informasi*, vol. 17, no. 1, pp. 58–71, Apr. 2021, doi: 10.21609/jsi.v17i1.1063.
[37] S. Wirtz and E. M. Jakobs, "Improving user experience for passenger information systems. Prototypes and reference objects," *IEEE Transactions on Professional Communication*, vol. 56, no. 2, pp. 120–137, Jun. 2013, doi: 10.1109/TPC.2013.2257211.
[38] M. Schrepp, A. Hinderks, and J. Thomaschewski, "Applying the user experience questionnaire (UEQ) in different evaluation scenarios," in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, vol. 8517 LNCS, no. PART 1, Springer International Publishing, 2014, pp. 383–392. doi: 10.1007/978-3-319-07668-3_37.
[39] H. Santoso, M. Schrepp, R. Y. Kartono Isal, A. Yudha Utom, and B. Priyogi, "Measuring the user experience," *The Journal of Educators Online*, vol. 13, no. 1, Jan. 2016, doi: 10.9743/jeo.2016.1.5.
[40] P. Abrahamsson, O. Salo, J. Ronkainen, and J. Warsta, "Agile software development methods: Review and analysis," *VTT Publications*, no. 478, pp. 3–107, Sep. 2002.
[41] I. Sommerville and P. Sawyer, *Requirements engineering: a good practice guide*. New York: Wiley, 1999.
[42] D. Tudor and G. A. Walter, "Using an agile approach in a large, traditional organization," in *Proceedings - AGILE Conference, 2006*, 2006, vol. 2006, pp. 367–373. doi: 10.1109/AGILE.2006.60.
[43] M. Cohn, *User stories applied: for agile software development*. Boston, MA: Addison-Wesley, 2004.

BIOGRAPHIES OF AUTHORS

Hery Dian Septama is an electrical and informatics engineering lecturer at the University of Lampung, Indonesia. He received a B.Sc. in electrical engineering with a computer systems and informatics major from the University of Lampung. He holds a master's in communication, Multimedia, and Electronics at the Faculty of Electrical Engineering, Czech Technical University in Prague. He is also a member of several organizations, including IEEE, APTIKOM, and IAII. His research areas are information systems, IoT, machine learning, IT governance, and computer networks. He can be contacted at email: hery@eng.unila.ac.id.

Lukmanul Hakim received a B.Eng. degree in electrical engineering from Sriwijaya University, Indonesia, an M.Sc. in electric power engineering from the University of Manchester, U.K., and a Dr. Eng. in complex systems engineering from Hiroshima University, Japan. He is a senior electrical and informatics engineering lecturer at the University of Lampung, Indonesia. Dr. Hakim is an IEEE member, and his research area covers modeling, simulation, optimization, and computation of power systems. He can be contacted at email: plgsekip@eng.unila.ac.id.

Meizano Ardhi Muhammad is an electrical and informatics engineering lecturer at the University of Lampung, Indonesia. He received a bachelor's degree in electrical engineering from the University of Lampung, majoring in computer systems and informatics. He holds a master's in informatics from Institut Teknologi Bandung, Indonesia. He has twenty years of experience in the information technology industry. Expertise in IT governance, smart city, intelligent transportation systems, mobile computing, library automation systems, and mixed reality. He can be contacted at: meizano@eng.unila.ac.id.

Fidha Rahmayani is a medical doctor, neurologist, senior lecturer, and head of the medical doctor profession program at the Medical Faculty, University of Lampung, Indonesia. She received the MD. degree in Medical Faculty from the University of Lampung. She holds a master's degree and neurologist at Medical Faculty of Universitas Gadjah Mada in Yogyakarta. Her research areas are neurology, neurophysiology, and neuroendocrine. She can be contacted at email: fidha.rahmayani@fk.unila.ac.id.

Dwi Indria Anggraini is a medical doctor, dermatovenereologist, pharmacologist, and senior lecturer at the Faculty of Medicine, University of Lampung, Indonesia. She also serves as vice chair of the Education Coordination Committee at Abdul Moeloek General Hospital (appointed teaching hospital), Indonesia. She received the MD. degree in Medical Faculty from the University of Sriwijaya. She holds a master's degree in biomedical science in Pharmacology with a major from Universitas Gadjah Mada and a dermatovenerologist from Universitas Indonesia. Her research interests are in dermatovenerology and pharmacology. She can be contacted at email: dwi.indria@fk.unila.ac.id.

Siska Lania is a medical doctor and head of the education and training installation who also serves as secretary of the Education Coordination Committee at Abdul Moeloek General Hospital (appointed teaching hospital), Indonesia. She received a medical doctorate in Medical Faculty from YARSI University. She holds a master's in public health from Universitas Malahayati, Indonesia. She can be contacted at email siskalania@gmail.com.

Robert Bestak obtained a PhD in computer science from ENST Paris, France (2003) and an MSc in telecommunications from Czech Technical University in Prague, CTU (1999). Since 2004, he has been an assistant professor at the Department of Telecommunication Engineering, Faculty of Electrical Engineering, and CTU. He participated in several national, EU, and third-party research projects. He is the Czech representative in the IFIP TC6 organization. He annually serves as a Steering and Technical Program Committee member of more than 20 international conferences (Networking, WMNC, and NGMAST). He is a member of the editorial board of 5 international journals with impact factors. He also acts as a reviewer for many journals published by IEEE, Elsevier, and Springer. He can be contacted at email: robert.bestak@fel.cvut.cz.