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INTUITIVE UI DESIGN FOR MANGROVE TREE DETECTION APP

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Abstract: The rapid degradation of mangrove ecosystems threatens coastal biodiversity, shoreline stability, and carbon sequestration capacity, particularly in areas experiencing intense human activity. However, community-based participatory mangrove monitoring remains limited due to the lack of accessible and user-friendly digital tools. This study aims to design an intuitive mobile application for mangrove tree detection and participatory ecological monitoring using a User-Centered Design (UCD) approach. The research was conducted iteratively through user needs analysis, prototype development, and usability evaluation involving local governments, conservation practitioners, and non-expert users. The proposed application integrates machine learning for automated mangrove recognition with geospatial visualization and real-time feedback to support field-based monitoring. Usability evaluation using the System Usability Scale (SUS) yielded an overall score of 82.3, categorized as excellent usability, indicating high user satisfaction and intuitive interaction. The results demonstrate that integrating UCD and machine learning enhances usability, user engagement, and the accuracy of mangrove documentation under real field conditions. Overall, this study presents a field-ready, user-centered mobile solution that bridges usability engineering and participatory mangrove monitoring as a replicable model for inclusive ecological application development.

Keywords: Carbon sequestration; mangrove monitoring; mobile application; user-centered design; usability evaluation

Abstrak: Degradasi ekosistem mangrove yang semakin cepat mengancam keanekaragaman hayati pesisir, stabilitas garis pantai, dan kapasitas sekuestrasi karbon, terutama di wilayah dengan aktivitas manusia yang intens. Namun, pemantauan mangrove secara partisipatif berbasis komunitas masih terbatas akibat kurangnya perangkat digital yang mudah diakses dan ramah pengguna. Penelitian ini bertujuan merancang aplikasi mobile yang intuitif untuk deteksi pohon mangrove dan pemantauan ekologi partisipatif dengan menggunakan pendekatan *User-Centered Design* (UCD). Penelitian dilakukan secara iteratif melalui analisis kebutuhan pengguna, pengembangan prototipe, dan evaluasi kegunaan dengan melibatkan pemerintah daerah, praktisi konservasi, serta pengguna non-ahli. Aplikasi yang diusulkan mengintegrasikan pembelajaran mesin untuk pengenalan mangrove secara otomatis dengan visualisasi geospasial dan umpan balik waktu nyata guna mendukung pemantauan di lapangan. Evaluasi kegunaan menggunakan *System Usability Scale* (SUS) menghasilkan skor keseluruhan sebesar 82,3 yang termasuk dalam kategori kegunaan sangat baik, menunjukkan tingkat kepuasan pengguna yang tinggi dan interaksi yang intuitif. Hasil penelitian menunjukkan bahwa integrasi UCD dan pembelajaran mesin meningkatkan kegunaan, keterlibatan pengguna, serta akurasi dokumentasi mangrove dalam kondisi lapangan. Secara keseluruhan, penelitian ini menyajikan solusi mobile berbasis UCD yang siap digunakan di lapangan dan menjembatani rekayasa kegunaan dengan pemantauan mangrove partisipatif sebagai model replikatif bagi pengembangan aplikasi ekologi yang inklusif.

Kata kunci: Carbon sequestration; mangrove monitoring; mobile application; user-centered design; usability evaluation

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INTRODUCTION

The rapid advancement of mobile technologies has enabled broader public participation in ecological monitoring and environmental stewardship, particularly through mobile applications designed for real-time interaction with natural ecosystems. Studies show that citizen science applications can significantly improve data accessibility and engagement when they are designed using principles that consider user needs and usability from the outset [1], [2], [3], [4], [5], [6]. In environmental informatics, user experience (UX) is one of the strongest determinants of sustained user adoption, particularly among non-expert communities such as coastal residents or conservation volunteers who often engage with these platforms in field conditions [7], [8].

User-Centered Design (UCD) is widely recognized as an effective development approach for sustainability-oriented systems because it emphasizes iterative refinement based on user context, behavior, and real-world usage conditions [2]. Prior research in human–computer–biosphere interaction indicates that ecological applications must align not only with functional requirements but also with users' perceptual and cognitive experiences when interacting with natural environments [9], [10], [1]. Moreover, usability evaluation frameworks such as the System Usability Scale (SUS) are commonly applied to assess whether a prototype meets real-world expectations in terms of clarity, accessibility, and ease of navigation [5], [3]. In environmental applications, usability becomes a critical prerequisite for adoption because target users often include first-time or low-tech users operating under field constraints [11], [12].

Mangrove ecosystems represent one of the most ecologically important coastal habitats due to their role in shoreline protection, biodiversity enhancement, and carbon sequestration [13], [14], [15], [16], [17]. Indonesia hosts more than 20% of global mangrove coverage; however, rapid degradation continues as a result of land conversion, coastal erosion, and unsustainable exploitation [18], [19], [20], [21]. Although national rehabilitation programs increasingly rely on remote sensing and geospatial data, ground-based validation and species-level documentation remain limited due to the absence of citizen-accessible and field-ready digital tools. This condition reveals a critical gap between advanced monitoring technologies and the practical capacity of local communities to participate directly in mangrove monitoring activities [15].

Recent technological developments demonstrate increasing interest in mangrove monitoring through geospatial platforms and artificial intelligence. Systems such as MANGLEE integrate satellite analytics for mangrove mapping [20], while Google Earth Engine-based applications are widely adopted for large-scale mangrove observation [21]. Other studies emphasize AI-powered biodiversity tools for conservation and education [13], as well as web-based systems for real-time ecological data access [2]. However, despite their technical sophistication, these systems remain predominantly expert-oriented and are not optimized for direct community use in field conditions. They frequently lack user-centered interface design, intuitive navigation, offline accessibility, and interaction simplicity, which limits their effectiveness in empowering non-specialist users such as students, ecotourism actors, and coastal residents [4], [9].

Based on this gap, existing mangrove monitoring technologies have not

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yet adequately integrated usability engineering with participatory ecological practices in a mobile, field-ready format. In particular, there remains a lack of mobile applications that combine mangrove detection capabilities with a rigorously evaluated user-centered interface tailored for non-expert users operating under real environmental conditions. Therefore, this study aims to design and evaluate a mobile-based mangrove tree detection interface using the User-Centered Design (UCD) approach to ensure usability, accessibility, and field readiness. The novelty of this research lies in its dual contribution: from a technical perspective, it explicitly integrates UCD with machine learning-based mangrove detection and validates the interface using the System Usability Scale (SUS) [5] from a social perspective, it enables participatory monitoring and citizen science by empowering non-expert community members to actively engage in mangrove identification and documentation [16], [17]. By bridging usability engineering and ecological relevance, this study addresses the unmet need for conservation technology that is both scientifically grounded and socially inclusive [22].

METHOD

This study applies the User-Centered Design (UCD) approach as defined in ISO 9241-210, which emphasizes iterative development based on user needs, usability objectives, and real-world usage context. UCD is selected because it is widely recommended in sustainability-oriented system development, where user accessibility and clarity of interaction strongly determine technology adoption in ecological applications [23].

The research follows four key UCD stages as outlined in ISO 9241-210:

Understanding and specifying the context of use

The process involves identifying user characteristics through interviews, creating personas with usage scenarios, and mapping functional problems encountered in mangrove monitoring.

Specifying user requirements

This involves translating user needs into system requirements, developing the content structure and information architecture, and determining feature priorities such as detection, location, carbon estimation, and offline mode.

Producing design solutions

The process includes creating low-fidelity wireframes, converting them into an interactive prototype, and refining the interface based on feedback loops.

Evaluating the design

Usability testing was conducted using the System Usability Scale (SUS), involving both expert and non-expert user groups, with findings triangulated from interaction testing and SUS scores.

Usability testing was conducted with 10 respondents, consisting of 5 individuals with prior knowledge of mangroves and 5 without any related experience. This sample size follows established usability testing guidelines indicating that early evaluations can be effectively conducted with 5–10 participants [24], [25]. The SUS method was chosen because it provides a reliable and widely validated usability benchmark and is suitable for prototype-level evaluation [26]. The results of the SUS evaluation were interpreted based on standard SUS scoring categories, which classify system usability into adjective scales ranging from "poor" to "excellent." This method ensures that the prototype is not only functional but also accessible to first-time users, providing a strong foundation for the future development of a fully implemented mangrove detection application.

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RESULT AND DISCUSSION

The context of use analysis identified two primary user groups: expert users with ecological knowledge and non-expert users with limited or no prior exposure to mangrove ecosystems. Both groups indicated a preference for clear visual interaction, minimal navigation layers, and rapid access to species information. These characteristics align with previous studies showing that usability and accessibility are critical determinants of adoption in sustainability-oriented mobile applications [23]. The development process followed the User-Centered Design framework based on ISO 9241-210, as illustrated in Image 1.

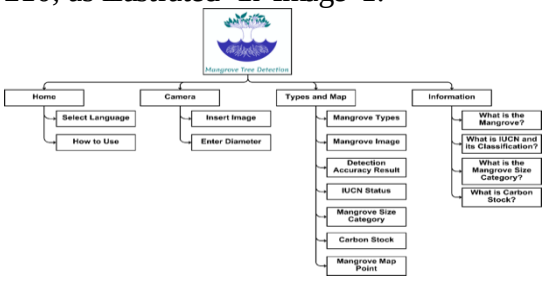

Image 1. UCD workflow of the proposed system

The resulting prototype integrates three key features: (1) image-based mangrove species identification, (2) ecological literacy panel with simplified descriptive content, and (3) a logging function for participatory monitoring. Usability was evaluated using the System Usability Scale (SUS) involving 10 respondents (five expert users and five non-expert users). The SUS results are presented in Table 1.

Table 1. Summary of SUS Scores

User Type	N	Mean SUS Score	Usability Category
Expert Users	5	84.0	Excellent
Non-Expert Users	5	80.5	Excellent
Overall	10	82.3	Excellent

The slightly higher score among expert users reflects familiarity with ecological terminology, while non-expert users benefited from the intuitive interaction design. This confirms that usability enables broader participation, reinforcing findings that inclusive interaction models are essential for ecological technology adoption [24]. The final prototype interface is illustrated in Image 2.

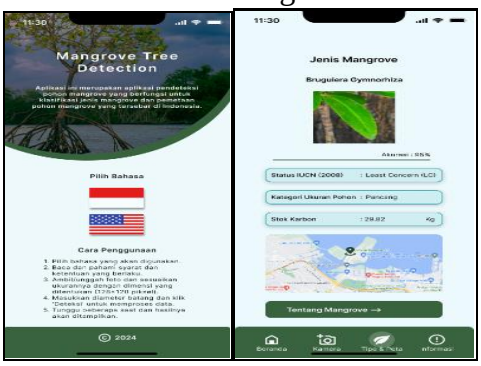

Image 2. Mobile interface prototype based on UCD evaluation results

Overall, the evaluation confirms that the use of UCD successfully bridges expert-level ecological knowledge and community participation. The prototype demonstrates that when usability considerations are integrated early in the design process, ecological applications can support both conservation literacy and citizen science engagement in coastal communities.

CONCLUSION

This study presents the development of a mobile-based UI/UX prototype for mangrove tree detection that explicitly integrates a User-Centered Design (UCD) framework with machine learning within a participatory mangrove monitoring context, following ISO 9241-210 guidelines. Based on standard System Usability Scale (SUS) benchmarks, the obtained score of 82.3 falls within the "excellent" usability category, indicating

a high level of user satisfaction and intuitive interaction for both expert and non-expert users. These results confirm that the proposed interface effectively meets user expectations in terms of clarity, accessibility, and interaction efficiency.

By embedding UCD principles at the early design stage, the application bridges expert-level ecological knowledge and community participation, thereby strengthening citizen science practices in mangrove monitoring. Future work will focus on implementing real-time image recognition, offline data capture, and geospatial logging to transform the prototype into a fully deployable mobile application, further supporting ecological literacy and long-term, community-based mangrove conservation initiatives

BIBLIOGRAPHY

[1] H. Ardiansyah and A. Fatwanto, "Application Design for Registration of Civil Appeals With Intuitive District Courts," *Ijid (International J. Informatics Dev.*, vol. 9, no. 1, p. 45, 2020, doi: 10.14421/ijid.2020.09107.

[2] G. Augusto, R. P. Duarte, and C. Cunha, "Enhancing Quality of Life: Human-Centered Design of Mobile and Smartwatch Applications for Assisted Ambient Living," *J. Auton. Intell.*, vol. 7, no. 1, 2023, doi: 10.32629/jai.v7i1.762.

[3] B. T. Ariyanto, Y. Ruldeviyani, G. S. B. Dharmawan, and M. I. Bahar, "Optimizing User Satisfaction: A Comprehensive Evaluation of the Info BMKG App Using UEQ+ and IPA Methods," *Int. J. Eng. Contin.*, vol. 3, no. 1, pp. 139–156, 2024, doi: 10.58291/ijec.v3i1.242.

[4] S. Supiyandi, C. Rizal, H. Hermansyah, and ..., "Desain Ui/Ux Sistem Informasi Hutan Mangrove Menggunakan Metode Rapid Application Development (Rad)," *Escaf*, pp. 1294–1300, 2024, [Online]. Available: https://semnas.univbinainsan.ac.id/index.php/escaf/article/view/699%0Ahttps://semnas.univbinainsan.ac.id/index.php/escaf/article/download/699/379

[5] J. Farao, B. Malila, N. Conrad, T. Mutsvangwa, M. X. Rangaka, and T. S. Douglas, "A User-Centred Design Framework for mHealth," *PLoS One*, vol. 15, no. 8, p. e0237910, 2020, doi: 10.1371/journal.pone.0237910.

[6] W. Ji, K. Han, and Q. Ge, "Route planning of mobile sensing fleets for repeatable environmental monitoring tasks," *Comput. Environ. Urban Syst.*, vol. 119, p. 102285, 2025, doi: https://doi.org/10.1016/j.compenvurbsys.2025.102285.

[7] R. U. Islam, M. S. Hossain, and K. Andersson, "A Deep Learning Inspired Belief Rule-Based Expert System," *Ieee Access*, 2020, doi: 10.1109/access.2020.3031438.

[8] G. Golubović *et al.*, "UI/UX design and usage effectiveness of mHealth applications: review paper," *Univers. Access Inf. Soc.*, vol. 24, no. 3, pp. 2091–2104, 2025, doi: 10.1007/s10209-025-01204-8.

[9] S. Supiyandi, C. Rizal, H. Hermansyah, and S. Khodijah, "Imple mentation of Rapid Application Development Methodology in UI/UX Design of Mangrove Forest Information System," *J. Inf. Syst. Res.*, vol. 6, no. 1, pp. 125–133, 2024, doi: 10.47065/josh.v6i1.5941.

[10] D. Hermansyah, M. Patiung, and N. S. Wisnujati, "Analisis trend dan prediksi produksi dan konsumsi komoditas sayuran sawi

(Brassica juncea L) di Indonesia Tahun 2020-2029," *Univ. Wijaya Kusuma Surabaya*, vol. 21, no. 22, pp. 34–46, 2021.

[11] N. Yingta, P. Saadati, J. Abdelnour-Nocera, O. Brew, T. Clemmensen, and I. U. Rehman, "Measuring UX at Work: A Diary Study of Healthcare Workers Ordinary Experiences With mHealth Apps," 2023, doi: 10.142 36/ewic/bcshci2023.7.

[12] K. Kuusinen and T. Mikkonen, "On Designing UX for Mobile Enterprise Apps," pp. 221–228, 2014, doi: 10.1109/seaa.2014.17.

[13] P. Baviskar and R. Dhiman, "Advancing the Spatiotemporal Assessment of Mangrove Ecosystem Using Machine Learning Approaches – Case Study of a Coastal Megacity, Mumbai, India," 2022, doi: 10.1002/essoar.10510134.1.

[14] S. C. Decena, C. Avorque, A. Arri bado, and D. Macasait, "Above ground and Belowground Carbon Stocks in Mangrove Ecosystems Along Carigara Bay in Leyte, Philippines," 2023, doi: 10.21203 /rs.3.rs-2910104/v1.

[15] G. R. Gaffara, M. R. Pratama, S. Kurniawan, and W. O. Nurhaidar, "The Mangrove Distribution Detec tion of National Capital Region (Case Study: Balikpapan Bay)," *Iop Conf. Ser. Earth Environ. Sci.*, vol. 1447, no. 1, p. 12003, 2025, doi: 10.1088/1755-1315/1447/1/012003.

[16] I. Y. Kurniawan, M. U. H. Al Rasyid, and S. Sukaridhoto, "Mangrove Tree Density Detector Using YOLO Based on Darknet Framework Using RGB Drone Imagery," *Int. J. Comput. Digit. Syst.*, vol. 15, no. 1, pp. 661–672, 2024, doi: 10.12785/ijcds/1601 49.

[17] J. Sui *et al.*, "Diversity and Structure of the Root-Associated Bacterial Microbiomes of Four Mangrove Tree Species, Revealed by High-Throughput Sequencing," *PeerJ*, vol. 11, p. e16156, 2023, doi: 10.7717/ peerj.16156.

[18] D. Kamthonkiat, C. Rodfai, A. Saiwanrungkul, S. Koshimura, and M. Matsuoka, "Geoinformatics in Mangrove Monitoring: Damage and Recovery After the 2004 Indian Ocean Tsunami in Phang Nga, Thailand," *Nat. Hazards Earth Syst. Sci.*, vol. 11, no. 7, pp. 1851–1862, 2011, doi: 10.5194/nhess-11-1851-2011.

[19] Y. Kumar Adimoolam, N. D. Pillai, G. Lakshmanan, D. Mishra, and V. Kumar Dadhwal, "Estimation of above ground biomass of mangrove forest plot using terrestrial laser scanner," *Egypt. J. Remote Sens. Sp. Sci.*, vol. 28, no. 1, pp. 1–11, 2025, doi: https://doi.org/10.1016 /j.ejrs.202 4.11.002.

[20] M. R. Nandika *et al.*, "How Drones and Lidar Help in Counting Mangrove Trees: A Practical Approach," *Geogr. Environ. Sustain.*, vol. 18, no. 3, pp. 88–98, 2025, doi: 10.24057/2071-9388-2025-3958.

[21] H. Niwa, H. Ise, and M. Kamada, "Suitable LiDAR Platform for Measuring the 3D Structure of Mangrove Forests," *Remote Sens.*, vol. 15, no. 4, p. 1033, 2023, doi: 10.3390/rs15041033.

[22] W. Wannasiri, M. Nagai, K. Honda, P. Santitamnont, and P. Miphokasap, "Extraction of Mangrove Biophysical Parameters Using Airborne LiDAR," *Remote Sens.*, vol. 5, no. 4, pp. 1787–1808, 2013, doi: 10.3390/rs5041787.

[23] F. Baihaqi, "Offline-First Mobile Applications for Remote Ecological Monitoring," in *SpringerLink*, 2024.