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Analysis and design of Hutanku application using Rapid application development

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ABSTRACT

This research aims to design the Hutanku application for bird location, tree, employee, and visitor databases using Rapid Application Development (RAD). The findings of this study indicate that the databases can be effectively utilized and prove beneficial in monitoring conservation areas. The primary objective of the research is to leverage RAD methodologies to design an application that facilitates efficient data collection, storage, and retrieval for bird locations, tree information, employee records, and visitor data within conservation zones. RAD's iterative and collaborative nature allows for swift adaptation to evolving user requirements, ensuring that the application is well-aligned with the specific needs of conservation monitoring. The successful implementation of the designed application highlights the practical utility of databases in enhancing the monitoring and management of conservation areas. In conclusion, the research underscores the significance of employing RAD for designing the Hutanku application, emphasizing its role in creating a robust database system essential for effective conservation practices.

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1. INTRODUCTION

The primary focus in optimizing vegetation monitoring involves designing a comprehensive spatial information system and database. A sophisticated approach to environmental surveillance necessitates the integration of spatial data, allowing for a holistic understanding of vegetation dynamics (Semedi et al., 2023). Such a system facilitates the seamless organization, storage, and retrieval of spatially referenced information, enabling researchers and practitioners to derive meaningful insights into vegetation patterns and changes over time (Fathoni et al., 2023). From an operational standpoint, implementing a spatial information system enhances the efficiency of monitoring processes by streamlining data collection, analysis, and reporting (Fatimatuzahra & Somantri, 2023). Additionally, integrating a spatial database ensures the accuracy and reliability of the collected information, thereby contributing to informed decision-making in resource management and conservation efforts (Achmad & Achmad, 2021). In conclusion, developing a robust spatial information system and database

emerges as a pivotal strategy in advancing the optimization of vegetation monitoring, fostering a more comprehensive and practical approach to ecological research and management.

The core objective of this research is to develop an application to optimize forest surveillance functions by utilizing spatial data. The imperative to enhance forest monitoring capabilities underscores the need for innovative technological solutions, and the proposed application seeks to address this gap (Shaw et al., 2022). Integrating spatial data becomes crucial to achieving a more effective and systematic approach to forest supervision (Zulfadli et al., 2023). The development of the application aligns with the growing demand for advanced tools that can harness spatial information for improved decision-making in the forest management (Sferlazza et al., 2021). Through the application's design, spatial data integration is anticipated to enable a more comprehensive forest ecosystem analysis, leading to informed strategies for conservation and sustainable resource utilization (Takam Tiamgne et al., 2022). In conclusion, the creation of this application signifies a noteworthy advancement in the realm of forest surveillance, fostering a technologically driven paradigm shift towards more efficient and data-driven monitoring practices.

The urgency of this research lies in preserving the environment through using technology as a spatial data system. Developing sustainable solutions is imperative at the forefront of contemporary environmental challenges (Cui et al., 2023). This research aims to harness spatial data systems' capabilities to address and mitigate environmental degradation effectively (Tariq et al., 2021). In support of this objective, the study recognizes the pivotal role that technology, particularly spatial data systems, can play in providing a comprehensive understanding of environmental dynamics (Xia et al., 2023). Technological advancements can foster more informed decision-making processes in the environmental conservation and management (Fernández Vargas et al., 2021). This research contends that leveraging spatial data technology is timely and critical in promoting long-term environmental sustainability (Breakpoint et al., 2022). In conclusion, the significance of this study is underscored by its commitment to advancing environmental preservation efforts through integrating spatial data technology, positioning it as a crucial contributor to the discourse on sustainable environmental management (Akbar Hossain et al., 2022).

The limitation of this research resides in the chosen method of designing the application based on Rapid Application Development (RAD) and the utilization of Oracle APEX in database design. While the RAD methodology offers agility and adaptability in software development, it may encounter challenges in accommodating intricate application requirements that demand a more structured and formal approach (Singgalen, 2024). Additionally, the use of Oracle APEX, though beneficial for its rapid development capabilities, may present limitations in handling complex database structures or large-scale datasets (Christanto, 2024). These constraints warrant careful consideration, as they may impact the scalability and robustness of the proposed application. Despite these limitations, the research acknowledges the trade-offs made in favor of expediency and ease of development, emphasizing the need for a balanced assessment of methodological choices. In conclusion, an awareness of these constraints provides a nuanced understanding of the research scope, guiding future endeavors toward refining methodologies for more comprehensive and efficient application development and database design.

Previous research with a similar focus indicates the necessity of designing a forest area monitoring information system as a proactive measure to anticipate landscape or vegetation changes that may result in ecological losses (Phiri et al., 2022). The primary objective of these studies is to underscore the critical role of information systems in enhancing the understanding of dynamic ecosystems and supporting timely decision-making for ecological preservation (Ramezani & Ramezani, 2021). By emphasizing the need for monitoring systems in forest areas, these investigations highlight the potential

ecological consequences of landscape and vegetation alterations, urging the implementation of proactive strategies (Tseveen et al., 2020). The importance of such systems lies in their ability to provide comprehensive and real-time data, aiding researchers and policymakers in formulating effective conservation measures (Brovkina et al., 2020). In conclusion, the findings from prior research validate the relevance of the proposed monitoring information system and emphasize the urgency of its implementation to mitigate potential ecological losses resulting from landscape and vegetation changes.

The research gap identified in previous studies lies in the disparity between theory and practice concerning monitoring conservation areas, particularly in the context of bird-watching tourism. While existing literature may provide theoretical frameworks and conceptual foundations for effective conservation monitoring, there appears to be a deficiency in bridging these theoretical insights with practical implementation, specifically in bird-watching activities within conservation zones. The gap suggests that translating theoretical knowledge into actionable strategies for on-the-ground monitoring and management of conservation areas, especially those involving recreational bird-watching, requires further exploration. Closing this gap is critical to establishing comprehensive and practical methodologies seamlessly integrated into conservation and ecotourism practices, ensuring the sustainability of environmental preservation and tourism activities. In conclusion, addressing this research gap is essential for advancing the effectiveness of monitoring practices in conservation areas, particularly in the unique context of bird-watching tourism.

The scientific contribution of this research lies in its significant role in advancing the fields of tourism bird-watching and environmental preservation through the implementation of digital solutions. The primary focus of the study is to provide a robust and technologically-driven approach, specifically through the development of a digital application named "Hutanku," aimed at enhancing the monitoring and management of conservation areas during bird-watching activities. The incorporation of digital solutions not only offers a systematic and efficient means of data collection but facilitates real-time analysis and decision-making processes. This research serves as a valuable addition to the existing body of knowledge, offering practical insights into integrating technology to promote sustainable tourism practices and reinforce environmental preservation efforts. In conclusion, the scientific contribution of this research manifests as a pivotal step toward harmonizing bird-watching tourism with effective environmental conservation through innovative digital solutions.

2. RESEARCH METHOD

Rapid Application Development (RAD) is an iterative, accelerated software development methodology emphasizing quick prototyping and feedback cycles. The central tenet of RAD is to expedite the application development process by involving end-users and stakeholders throughout the project's life cycle (Sihombing, 2023). In RAD, the development team collaborates closely with users to gather requirements and rapidly build and refine iterative prototypes based on continuous user feedback (Fauzi et al., 2023). This approach aims to deliver functional software quickly, allowing flexibility in adapting to evolving user needs and requirements (Suni et al., 2023). While RAD is lauded for its agility and responsiveness, some critics argue that its emphasis on speed may compromise the long-term scalability and maintainability of the software. In conclusion, the effectiveness of RAD lies in its ability to produce functional prototypes and engage stakeholders actively swiftly. Still, its suitability depends on each development project's requirements and constraints, as shown in the Figure Below.

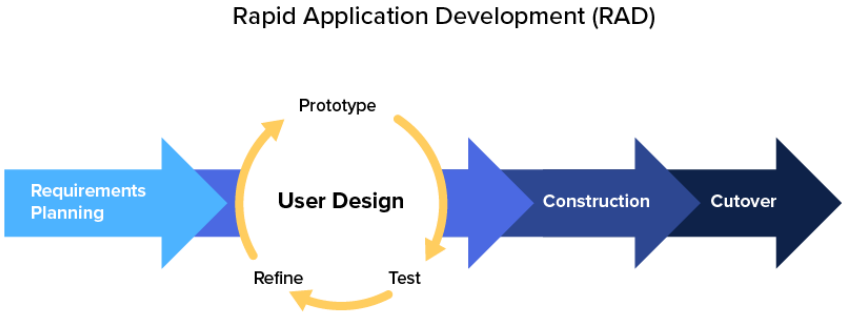

Figure 1. Rapid Application Development

Figure 1 shows the stages of RAD. Rapid Application Development (RAD) encompasses a series of sequential phases: requirements planning, user design, construction, and cutover. The requirements planning phase initiates the RAD process by emphasizing close collaboration between developers and end-users to identify and define project requirements. Subsequently, the user design phase involves iterative prototyping, where end-users actively participate in designing and refining the system's functionality. The construction phase follows, where the actual development of the application takes place, incorporating the insights gathered from earlier prototyping stages. Finally, the cutover phase involves transitioning from the development environment to the operational one, ensuring a smooth application deployment. While RAD's iterative nature and user involvement expedite the development process, some critics argue that its emphasis on speed may compromise thoroughness in design and testing. In conclusion, the structured progression through these phases in RAD enables swift development and incorporation of user feedback. Yet, carefully considering potential trade-offs is essential for optimal outcomes in software development projects.

2.1 Requirements Planning

The requirement planning phase identifies data needs for the "Hutanku" application. The primary objective of this phase is to meticulously analyze and define the data requirements essential for the successful development and functionality of the application. This involves thoroughly examining the information necessary for effective forest management, encompassing variables such as biodiversity, vegetation types, and ecological patterns. The meticulous identification of these data needs is the foundation for subsequent stages in the Rapid Application Development (RAD) process, ensuring that the application is tailored to the specific forest monitoring and management requirements. In conclusion, the requirement planning phase serves as a critical starting point, laying the groundwork for successfully integrating data elements within the "Hutanku" application, ultimately contributing to its effectiveness in supporting informed decision-making in forest conservation and management efforts.

Table 1. Requirement Planning for “Hutanku” Application

Data	Raster Calculation
Bird Location Database	The benefits of bird location data are multifaceted, contributing significantly to ornithological research, biodiversity conservation, and ecosystem monitoring. This data enables researchers and conservationists to understand the distribution, migration patterns, and habitat preferences of various bird species, providing insights into their ecological roles and behaviors.
Tree/Forest Database	The database allows for the tracking of tree species distribution, abundance, and regeneration patterns over time, aiding in the assessment of forest dynamics and potential environmental changes
Conservator Employee Database	The conservator employee database facilitates efficient personnel management by storing and organizing essential details about conservator employees, including their qualifications, roles, responsibilities, and work history.

Visitor Database and Bird Watching Event	The visitor database enables the systematic recording of visitor information, including preferences, visitation history, and feedback. This data can be utilized to tailor bird-watching programs, events, and educational initiatives to the specific interests and needs of the visitors, thereby enhancing their overall experience.

Table 1 shows the requirement planning for Hutanku application. The outcomes of the user needs identification process reveal a demand for diverse databases crucial to conservation and bird-watching activities, namely the Bird Location Database, Tree/Forest Database, Conservator Employee Database, and Visitor Database for Bird Watching Activity. The primary focus lies in acknowledging the multifaceted requirements of stakeholders involved in conservation efforts. The Bird Location Database is imperative for ornithological research, providing insights into bird distribution, migration patterns, and habitat preferences. The Tree/Forest Database facilitates systematic forest management by organizing information related to tree species, composition, and ecological parameters. The Conservator Employee Database addresses the need for efficient personnel management and workforce planning within conservation organizations. Lastly, the Visitor Database for Bird Watching Activity recognizes the significance of tailored engagement and efficient site management to enhance the bird-watching experience. In conclusion, identifying these user needs underscores the comprehensive nature of conservation efforts, necessitating a range of specialized databases to support informed decision-making and sustainable management practices.

2.2 User Design

In the user design phase, the development process advances to the design of the user interface for the "Hutanku" application, utilizing Oracle APEX. This pivotal stage involves crafting the application's visual elements and interactive components to ensure an intuitive and user-friendly experience. Oracle APEX, known for its capability to streamline web application development, is employed to create a cohesive and visually appealing interface. The user interface design is meticulously tailored to meet the specific needs of the end-users, taking into account their preferences and usability expectations. This phase is critical in shaping the overall user experience, fostering efficient interaction with the application, and enhancing user engagement. In conclusion, the user design stage, coupled with the utilization of Oracle APEX, not only prioritizes functionality but also emphasizes the importance of a visually compelling and user-centric interface in optimizing the overall usability of the "Hutanku" application.

2.3 Construction

During the construction phase, the focus shifts to configuring Oracle APEX to align with the outcomes of the identified data needs, encompassing the Bird Location Database, Tree/Forest Database, Conservator Employee Database, and Visitor Database for Bird Watching Activity. This stage involves the implementation of the database configurations and structures necessary to accommodate the specific requirements of each identified data category. A flexible and tailored approach is adopted to configure the application through Oracle APEX, ensuring seamless integration with the diverse datasets. The construction phase plays a pivotal role in translating the conceptual design into a functional application, providing the necessary framework to capture, store, and manage the information associated with bird locations, forest details, employee records, and bird-watching visitors. In conclusion, the configuration of Oracle APEX in the construction phase is a critical step that underlines the adaptability and efficiency of the chosen technology in meeting the identified data needs for a comprehensive and well-integrated "Hutanku" application.

2.4 Cutover

During the cutover phase, a crucial step involves conducting trial runs of the "Hutanku" application based on Oracle APEX to evaluate the features and functions of Create, Read, Update, and Delete (CRUD) operations. This phase entails a systematic and

comprehensive assessment of the application's performance in handling data creation, retrieval, updating, and deletion. By engaging in these trial evaluations, the development team aims to identify potential issues, refine functionalities, and ensure that the CRUD operations operate optimally. The iterative testing process allows for fine-tuning the application's responsiveness and effectiveness in managing diverse datasets related to the Bird Location Database, Tree/Forest Database, Conservator Employees, and Visitors for Bird Watching Activity. In conclusion, the cutover phase is a critical juncture for validating the practicality and efficiency of the Oracle APEX-based "Hutanku" application, ensuring that CRUD functionalities are operational and optimized for seamless and effective data management.

3. RESULTS AND DISCUSSIONS

The "Hutanku" application is intricately linked to bird-watching activities, serving as a pivotal tool to enrich and optimize the overall bird-watching experience (Murib & Therik, 2023). The application's primary purpose is to provide a comprehensive platform for managing and monitoring various aspects of bird watching within conservation areas (Cristina et al., 2023). The application facilitates the systematic recording and analysis of bird sightings, visitor preferences, and site utilization patterns through features such as the Bird Location Database and the Visitor Database for Bird-Watching Activity (Agustin et al., 2023). This integration of functionalities caters to the specific needs of bird-watching enthusiasts, allowing them to access real-time information on bird locations, plan visits more effectively, and actively contribute to conservation efforts (Suana et al., 2020). Therefore, the "Hutanku" application is a testament to the seamless convergence of technology and nature-based recreation, offering a valuable resource that enhances the bird-watching experience while promoting environmental conservation. In conclusion, the application bridges technology and birdwatching's serenity, fostering a harmonious synergy between recreational activities and conservation endeavors.

Based on the outcomes of the "Hutanku" application design, it is evident that the management of conservation forest areas can be effectively monitored by integrating a comprehensive database and information system. The primary focus of the application design centers on creating a robust platform that facilitates the systematic organization and real-time accessibility of data related to bird locations, tree/forest details, conservator employees, and bird-watching visitors. Integrating data and information systems enables efficient monitoring, analysis, and decision-making processes essential for effective conservation management. The application's structured design fosters a holistic approach, allowing for monitoring ecological variables, tracking visitor activities, and managing human resources involved in conservation efforts. In conclusion, the "Hutanku" application design signifies a pivotal step towards advancing the monitoring capabilities of conservation forest management, providing a technological solution poised to enhance conservation practices' overall effectiveness and sustainability.

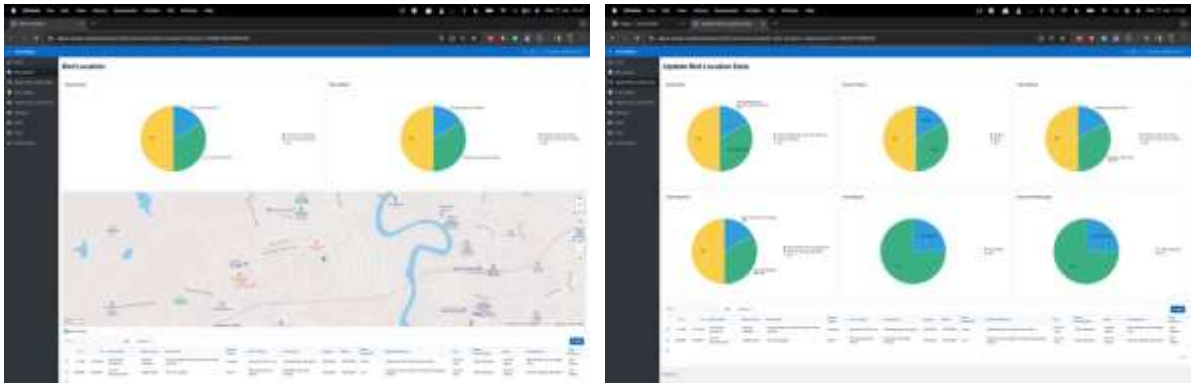

Figure 2. Bird Location Dashboard and Update Form

The database dashboard for bird observation emphasizes presenting comprehensive data related to observed bird locations and specific information, thereby enabling precise location determination to organize bird-watching events. The central focus of the dashboard lies in visualizing and analyzing the geographical distribution of observed bird species, allowing event organizers to plan bird-watching activities strategically. Through detailed information on bird habitats, migratory patterns, and sighting frequencies, the dashboard aids in selecting optimal locations for bird-watching events, enhancing the chances of diverse and captivating bird sightings. The specificity of data provided by the dashboard ensures that event organizers can tailor their activities to align with the preferences and interests of bird-watching enthusiasts, ultimately contributing to the success and enrichment of the overall bird-watching experience. In conclusion, the bird observation database dashboard is a crucial tool for event planning, optimizing the utilization of observed bird data to create engaging and informative bird-watching events.

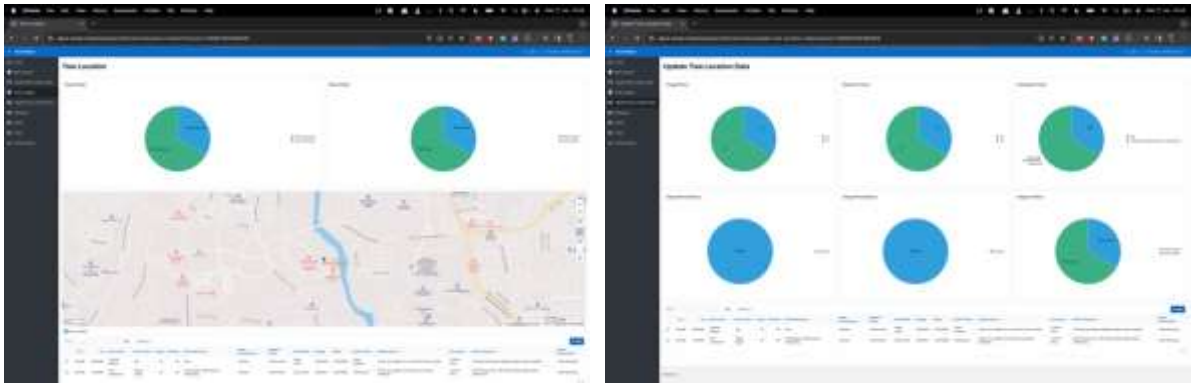

Figure 3. Tree Location Dashboard and Update Form

The tree location database dashboard primarily emphasizes presenting data related to observed tree locations, coupled with specific information, aiming to provide insights into the existing condition of the forest area and guide practical intervention efforts. The main objective of the dashboard is to visualize the spatial distribution of observed trees and offer detailed information about their species, health status, and ecological roles. By highlighting specific details such as tree density, diversity, and health indicators, the dashboard becomes instrumental in assessing the overall health of the forest ecosystem. This specificity in information is crucial for formulating targeted strategies and interventions to address issues such as deforestation, habitat degradation, or the spread of diseases affecting trees. The tree location database dashboard is a valuable forest management tool, offering insights for informed decision-making and proactive conservation measures. In conclusion, the dashboard provides a comprehensive

overview of tree locations, contributing to a deeper understanding of the forest landscape and facilitating strategic efforts towards its preservation and sustainable management.

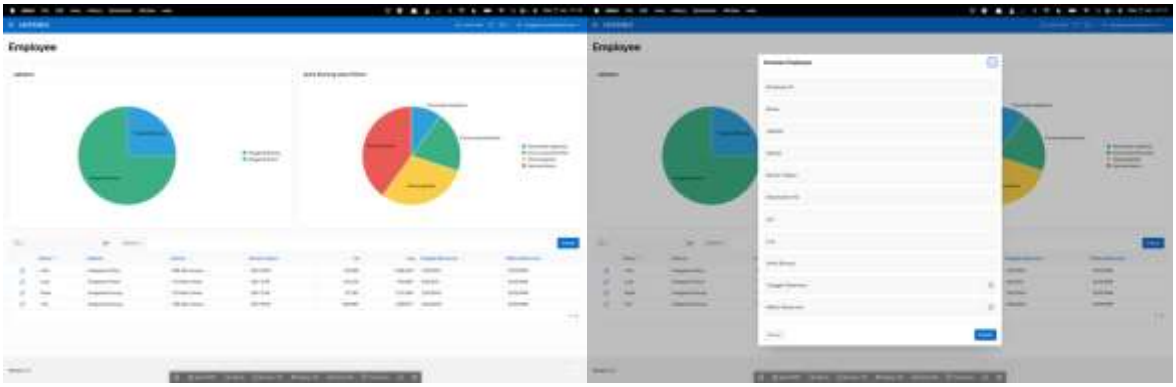

Figure 4. Employee Database and Update Form

The conservatory employee database dashboard primarily presents comprehensive data on bird and tree observations within the conservation area, coupled with a detailed history of observation outcomes. The main objective of this dashboard is to provide conservatory employees with a centralized platform to record, monitor, and analyze their observations of birds and trees. By emphasizing specific information such as observation locations, species identification, and historical data, the dashboard enables conservators to derive meaningful insights into the ecological dynamics of the conservation area. This specificity in information not only aids in the documentation of biodiversity but also assists in identifying patterns, assessing changes over time, and informing conservation strategies. Therefore, the conservatory employee database dashboard is a valuable tool for facilitating informed decision-making, enhancing the effectiveness of conservation efforts, and contributing to the overall ecological management of the conservation area. In conclusion, the dashboard is an indispensable resource for conservatory employees, fostering a systematic data collection and analysis approach for more robust conservation practices.

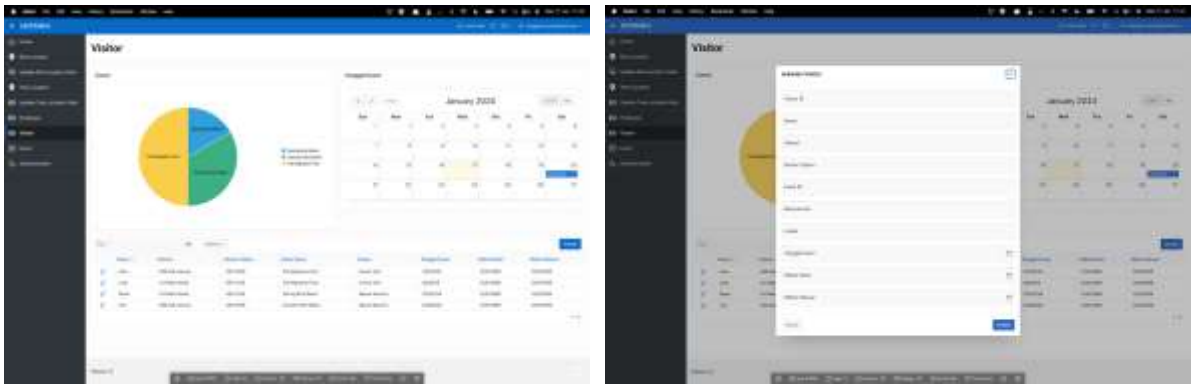

Figure 5. Visitor Database and Update Form

The visitor database dashboard primarily emphasizes presenting comprehensive data related to visitors based on bird-watching events, including each event's start and end times. The central objective of this dashboard is to provide a systematic overview of visitor engagement during bird-watching activities. By focusing on event-specific data such as attendance, duration, and visitor demographics, the dashboard facilitates a nuanced understanding of the popularity and success of individual bird-watching events.

This detailed information enables event organizers to tailor future activities to meet visitor preferences and optimize resource allocation for enhanced visitor experiences. The specificity in data presentation enhances the overall management of bird-watching events, providing valuable insights into the temporal patterns of visitor engagement. In conclusion, the visitor database dashboard serves as a crucial tool for event planning, allowing organizers to analyze and improve the effectiveness of their initiatives, ultimately contributing to the sustained success of bird-watching activities.

Based on the outcomes of the "Hutanku" application design, it is evident that databases about birds, trees, employees, and visitors are essential for optimizing the management of the forest area. The primary focus of the application design centers around the systematic organization and integration of data, ensuring a comprehensive understanding of the ecological dynamics within the conservation area. The bird and tree databases contribute to ecological monitoring and conservation efforts, providing insights into species distribution, habitat preferences, and overall forest health. Additionally, the employee database facilitates efficient human resource management for conservation activities, while the visitor database aids in planning and enhancing bird-watching events. Integrating these databases underscores the holistic approach to forest management, promoting informed decision-making and sustainable conservation practices. In conclusion, the designed application underscores the critical role of comprehensive databases in fostering effective and sustainable management practices within the forest area.

4. CONCLUSION

Implementing Rapid Application Development (RAD) in designing the "Hutanku" application yields significant benefits in documenting location-specific information related to birds and trees within the conservation area. The scientific contribution of this research lies in its significant role in advancing the fields of tourism bird-watching and environmental preservation through the implementation of digital solutions. RAD's iterative and collaborative approach allows for swift prototyping and continuous user feedback, ensuring the incorporation of specific data needs, such as bird and tree observations, in a dynamic and adaptable manner. Furthermore, RAD proves advantageous in documenting information about conservator employees and visitors during bird-watching events. The flexibility of RAD enables efficient adjustments to the application's features, including data recording functionalities, ensuring that the system accurately captures and manages diverse information about conservation efforts. In conclusion, by prioritizing user input and adaptability, the RAD methodology emerges as a valuable approach to designing the "Hutanku" application, fostering a comprehensive documentation process essential for effective conservation management and bird-watching event organization.

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REFERENCES

Achmad, M. I., & Achmad, M. I. (2021). Desain Sistem Peringatan Dini Bencana Kebakaran Hutan Berbasis Jaringan Sensor dan Short Message Service (SMS). *Sang Pencerah: Jurnal Ilmiah Universitas Muhammadiyah Buton*, *9*(2), 21–31.

Agustin, I. Y., Hakim, L., & Leksono, A. S. (2023). Mammals and Bird Conservation Strategies

Through Community-Based Wildlife Watching Ecotourism Development in Perhutani Area in Poncokusumo, Malang District, East Java. *Biotropika: Journal of Tropical Biology*, *11*(1), 44–52. https://doi.org/10.21776/ub.biotropika.2023.011.01.06

Akbar Hossain, K., Masiero, M., & Pirotti, F. (2022). Land cover change across 45 years in the world's largest mangrove forest (Sundarbans): the contribution of remote sensing in forest monitoring. *European Journal of Remote Sensing*, *00*(00), 1–17. https://doi.org/10.1080/22797254.2022.2097450

Breakpoint, T., Monitoring, F., Zhang, Y., Wang, L., Zhou, Q., Tang, F., Zhang, B., Huang, N., & Nath, B. (2022). Continuous Change Detection and Classification—Spectral Trajectory Breakpoint Recognition for Forest Monitoring. *Land*, *11*(504), 1–22.

Brovkina, O., Stojanović, M., Milanović, S., Latypov, I., Marković, N., & Cienciala, E. (2020). Monitoring of post-fire forest scars in Serbia based on satellite Sentinel-2 data. *Geomatics, Natural Hazards and Risk*, *11*(1), 2315–2339. https://doi.org/10.1080/19475705.2020.1836037

Christanto, H. J. (2024). Jurnal Mantik Analysis and design of SIDATA as database management for the final project using Rapid Application Development. *Jurnal Mantik*, *7*(51), 3043–3054.

Cristina, M., Sánchez, O., & Jorge, J. P. (2023). Turismo de observación de aves " Aviturismo " como contribución a la sostenibilidad – el caso de la Reserva de Biosfera Yasuní en el Ecuador. *RITUR - Revista Iberoamericana de Turismo*, *13*(1), 173–191.

Cui, B., Zhang, Y., Liu, L., Gu, C., Wang, Z., Wei, B., & Gong, D. (2023). Spatial-temporal dynamics of transboundary forest disturbance-recovery and its influencing factors in the central Himalayas. *Geocarto International*, *38*(1), 1–26. https://doi.org/10.1080/10106049.2023.2228267

Fathoni, S., Nabella, Nurmala, V. F., & Prayoga, M. B. R. (2023). Pengelolaan Rawa Gambut Sebagai Upaya Mitigasi Bencana Kebakaran Hutan Dan Lahan Di Provinsi Riau Guna Mendukung Keamanan Nasional. *Jurnal Manajemen Bencana (JMB)*, *8*(2), 53–71.

Fatimatuzahra, D. T., & Somantri. (2023). Perancangan Web Geographic Information System (WebGIS) Kehutanan Pada Wilayah Sukabumi. *Jurnal Tekno Kompak*, *17*(1), 184–195.

Fauzi, M. A., Tribiakto, H., Moniva, A., Khalid Ilyas, I., & Utami, E. (2023). Systematic Literature Reviews on Rapid Application Development Information System. *Bulletin of Computer Science and Electrical Engineering*, *4*(1), 57–64. https://doi.org/10.25008/bcsee.

Fernández Vargas, T., Trejo Vázquez, I., & Aguirre Gómez, R. (2021). Remote sensing based forest canopy opening and their spatial representation. *Forest Science and Technology*, *17*(4), 214–224. https://doi.org/10.1080/21580103.2021.2002198

Murib, Y., & Therik, W. M. A. (2023). Peran Pembangunan Bird Watching Isyo Hill ' s Sebagai Upaya Menghadapi Perusahaan Kelapa Sawit di Kampung Rhepang Muaif Distrik Nimbokrang Kabupaten Jayapura Papua . *Kritis*, *32*(2), 88–116.

Phiri, D., Chanda, C., Nyirenda, V. R., & Lwali, C. A. (2022). An assessment of forest loss and its drivers in protected areas on the Copperbelt province of Zambia: 1972–2016. *Geomatics, Natural Hazards and Risk*, *13*(1), 148–166. https://doi.org/10.1080/19475705.2021.2017021

Ramezani, H., & Ramezani, A. (2021). Forest fragmentation assessment using field-based sampling data from forest inventories. *Scandinavian Journal of Forest Research*, *36*(4), 289–296. https://doi.org/10.1080/02827581.2021.1908592

Semedi, B., Marjonob, Savitric, N. L. E., Hikmawatic, Viona Faiqoh Bayuajia, G. D. A. P., Syam'sa, N. D. S., & Diza, N. F. (2023). Pemanfaatan Google Earth Engine Untuk Memantau Perubahan Luasan Hutan Mangrove Di Probolinggo. *JFMR-Journal of Fisheries and Marine Research*, *7*(2), 79–87. https://doi.org/10.21776/ub.jfmr.2023.007.02.9

Sferlazza, S., Maltese, A., Ciraolo, G., Dardanelli, G., Maetzke, F. G., & La Mela Veca, D. S. (2021). Forest accessibility, Madonie mountains (northern Sicily, Italy): implementing a GIS decision support system. *Journal of Maps*, *17*(2), 464–473. https://doi.org/10.1080/17445647.2021.1962751

Shaw, A., Steelman, T., & Bullock, R. (2022). Evaluating the efficacy of GIS maps as boundary objects: unpacking the limits and opportunities of Indigenous knowledge in forest and natural resource management. *Journal of Cultural Geography*, *39*(1), 90–116. https://doi.org/10.1080/08873631.2021.2011683

Sihombing, D. (2023). Development of construction project cost budget application using rapid application development method. *Jurnal Mantik*, *7*(3), 2685–4236.

Singgalen, Y. A. (2024). Implementation of rapid application development for spatio-temporal database management. *Jurnal Mantik*, *7*(4), 2974–2984.

Suana, I. W., Ahyadi, H., Hadiprayitno, G., Amin, S., Kalih, L. A. T. T. W. S., & Sudaryanto, F. X.

(2020). Environment carrying capacity and willingness to pay for bird-watching ecotourism in Kerandangan Natural Park, Lombok, Indonesia. *Biodiversitas*, *21*(5), 2266–2274. https://doi.org/10.13057/biodiv/d210557

Suni, E. K., Jean, D., Sihombing, C., Jean, D., & Sihombing, C. (2023). Jurnal Mantik Analysis and development of sipemas : community complaint applications using the rapid application development method. *Jurnal Mantik*, *7*(3), 2694–2702.

Takam Tiamgne, X., Kanungwe Kalaba, F., Raphael Nyirenda, V., & Phiri, D. (2022). Modelling areas for sustainable forest management in a mining and human dominated landscape: A Geographical Information System (GIS)- Multi-Criteria Decision Analysis (MCDA) approach. *Annals of GIS*, *28*(3), 343–357. https://doi.org/10.1080/19475683.2022.2026469

Tariq, A., Shu, H., Siddiqui, S., Mousa, B. G., Munir, I., Nasri, A., Waqas, H., Lu, L., & Baqa, M. F. (2021). Forest fire monitoring using spatial-statistical and Geo-spatial analysis of factors determining forest fire in Margalla Hills, Islamabad, Pakistan. *Geomatics, Natural Hazards and Risk*, *12*(1), 1212–1233. https://doi.org/10.1080/19475705.2021.1920477

Tseveen, B., Natsagdorj, E., Balgan, A., Renchin, T., Norovsuren, B., & Mart, Z. (2020). Impact of logging operations on forest ecosystem in the Khantai mountain region and forest cover mapping. *Forest Science and Technology*, *16*(3), 123–133. https://doi.org/10.1080/21580103.2020.1796830

Xia, S., Yang, Z., Zhang, G., & Wu, X. (2023). Forest Cover Change Monitoring Using Sub-Pixel Mapping with Edge-Matching Correction. *Forests*, *14*(9), 1–22. https://doi.org/10.3390/f14091776

Zulfadli, A., Kharisma, O. B., Simaremare, H., & Ismaredah, E. (2023). Pendeteksi Penebang Liar Menggunakan Sensor Suara Max4466 Di Kawasan Hutan. *Transmisi: Jurnal Ilmiah Teknik.*