

Revitalizing Faculty Open Space Through Local Flora and Technological Integration

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Abstract

Green open spaces within university environments play a crucial role in enhancing academic, social, and ecological quality. At the Faculty of Science and Technology, Universitas Jambi (FST UNJA), the existing park has not yet functioned optimally due to a non-functional landscape layout, unsystematic use of local flora, and the absence of technological integration to support sustainability. These conditions have resulted in limited social interaction, inadequate environmental education functions, and a lack of intelligent systems for efficient green space management. Therefore, revitalizing the faculty's open space has become an urgent initiative to realize the university's vision of creating a green, innovative, and competitive academic environment. This study aims to design, implement, and integrate a technology-based green park (smart eco-park) that functions as a communal area, an interdisciplinary learning platform, and a pilot model for sustainable open-space management. Using an applied research design combining qualitative and quantitative methods, the study comprises four stages: pre-design analysis and surveys, landscape and technological system design, physical implementation, and subsequent evaluation. The main innovations include the use of local flora, application of smart irrigation systems, humidity sensors, and plant QR codes to enhance user engagement and data-driven environmental learning. This research contributes to scientific advancement and physics education by demonstrating the practical application of sensor-based monitoring systems, environmental data acquisition, and energy-efficient technologies to support sustainability and interdisciplinary learning within a university setting.

Keywords: Campus Green Open Space; Landscape Revitalization; Local Flora; Smart Eco-Park; Smart Technology

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INTRODUCTION

A modern university campus functions not only as a site for formal education, but also as a living ecosystem that supports social interaction and the creative activities of its academic community. Within the broader context of built environment planning and management, green open spaces play a strategic role as the “lungs” of the campus, an ecological buffer, and a communal setting that accommodates both academic and non-academic activities. Properly designed and well-managed green spaces have the potential to enhance micro-climate quality, strengthen spatial identity, and serve as a medium for interdisciplinary learning and innovation [1,2].

At the Faculty of Science and Technology, Universitas Jambi (FST UNJA), there is a garden area (Figure 1) that was initially established as a green space element as well as a communal facility. However, preliminary observations indicate that the existing condition of the garden has not yet achieved its intended optimal function. A loosely planned landscape, unstructured vegetation layout, and limited supporting amenities have collectively constrained the garden’s ability to function as a representative setting for academic interaction. Consequently, the garden has not provided significant added value to either the environmental quality of the campus or the social activities of its academic community.

In responding to the growing demands for improving the quality of the academic environment, the presence of a campus garden that is green, functional, and technology-integrated has become increasingly essential. A garden functions not merely as an aesthetic element, but also as a space for recreation, relaxation, social interaction, and experiential learning [3,4]. Moreover, the rich diversity of local flora in Jambi can be incorporated into the landscape design, thereby enabling the garden to serve a dual purpose as a medium for conservation, biological education, and the reinforcement of local identity within the academic setting.



Figure 1. Existing conditions of the gardens within the FST UNJA campus environment.

Beyond ecological and social aspects, recent advancements in digital technologies and intelligent systems offer new opportunities for more efficient and adaptive green space management. The implementation of smart irrigation systems for water efficiency, soil moisture sensors for vegetation monitoring, QR codes for botanical information, and interactive Internet of Things (IoT) applications can be integrated into the garden system. Through this approach, the garden is transformed from a passive green area into a sustainable and interactive smart eco-park that can serve as a model for innovative academic communal spaces.

Accordingly, the revitalization of the FST Garden should be directed toward strengthening its ecological, social, and technological functions in an integrated manner. The garden is envisioned not merely as a passive landscape element, but as an innovative communal space capable of enhancing academic interaction, enriching learning experiences, and serving as a living laboratory for the application of science, technology, engineering, and mathematics. This initiative aligns with the vision of Universitas Jambi to develop an adaptive, sustainable, and locally rooted campus environment. In line with this background, the present study aims to: (1) design and implement a revitalization concept for the FST Garden that enables it to function optimally as an innovative communal space supporting social and academic activities; (2) identify, select, and integrate appropriate local flora to enhance the ecological, conservation, and educational functions of the garden; (3) develop and incorporate intelligent technological systems - such as smart irrigation, soil-moisture sensors, plant-information QR codes, and interactive applications - into the garden management framework; and (4) evaluate the impact of the revitalized garden on social interaction, comfort, and user satisfaction within the Faculty of Science and Technology.

METHODS

This study adopts an applied research design that integrates qualitative and quantitative approaches. The qualitative component is employed to explore user needs, preferences, and perceptions regarding the FST Garden through surveys, interviews, and direct observation. Meanwhile, the quantitative component is used to measure the performance of technological systems - such as automated irrigation efficiency, water consumption, and environmental sensor responses - and to assess the impact of the revitalized garden on user satisfaction using standardized questionnaires. The research is conducted at FST UNJA. The study spans the period from the pre-research survey (baseline assessment) to the implementation and evaluation stages throughout the 2025 academic year. Field observations, data collection, and design assessment are carried out directly within the FST Garden and its surrounding campus environment.

The research targets include two main groups: (1) Physical and environmental conditions of the FST Garden, encompassing landscape elements, vegetation, circulation patterns, and supporting infrastructure. (2) Users of the garden, consisting of students, lecturers, and staff within FST UNJA. Participants for qualitative data collection are selected using purposive sampling to ensure representation of various user groups, while respondents for quantitative satisfaction surveys follow a simple random sampling technique.

Pre-Design Stage

The pre-design stage focuses on establishing a comprehensive baseline dataset to support the subsequent design process. From the civil engineering perspective, this stage includes detailed site surveys, assessments of soil structure and bearing conditions, drainage evaluations, and analyses of infrastructure feasibility. From the architectural perspective, spatial configuration studies are conducted to examine existing layout patterns, pedestrian circulation flows, and potential functional zoning within the garden area. Meanwhile, the biological component involves a complete inventory of flora, emphasizing species diversity, ecological roles, adaptability to the local climate, and conservation potential. This stage is further strengthened through an extensive review of relevant literature and structured interviews with key campus stakeholders to identify user needs, expectations, and constraints.

Design and Planning Stage

The design and planning stage involves the synthesis of data gathered during the pre-design phase into an integrated revitalization concept. The architecture team develops the final landscape design by emphasizing ecological sustainability, social functionality, and aesthetic harmony within the campus environment. The biology team identifies and selects priority local flora that not only support biodiversity enrichment but also serve as educational resources for the academic community. The civil engineering team ensures that the proposed design is technically feasible, particularly regarding the integration of pedestrian pathways, drainage systems, and supporting utility networks. In parallel, the electrical engineering team formulates the design of smart technologies, including automated irrigation systems, environmental sensors for soil and climate monitoring, and QR-coded plant information platforms to enable interactive learning.

Implementation Stage

The implementation stage consists of executing the revitalization design through coordinated landscape development and technological installation. This includes site preparation activities such as area clearing, restructuring of the landscape, improvement of circulation routes, and construction of basic physical facilities. Selected flora are planted according to the approved layout, ensuring alignment with ecological and educational objectives. Additionally, smart systems - comprising IoT-based environmental sensors, smart irrigation devices, and interactive QR-code interfaces - are installed and configured to facilitate real-time monitoring and adaptive management of the garden environment.

Evaluation and Monitoring Stage

The final stage involves the systematic evaluation and monitoring of the revitalized garden to assess its performance and impact. Quantitative data are collected from IoT-based sensors, including water consumption, soil moisture levels, and environmental conditions. User satisfaction is measured through standardized questionnaires distributed to students, staff, and faculty members. Observational studies are also conducted to document social interaction patterns and user engagement within the revitalized space. These datasets are subsequently analyzed to determine improvements in ecological performance, social functionality, and educational value, thereby validating the effectiveness of the revitalization strategy and identifying opportunities for further enhancement.

A combination of qualitative and quantitative instruments is employed to obtain comprehensive data relevant to the revitalization of the FST Garden. Observation sheets are utilized to document the physical condition of the site, environmental parameters, and user activities within the garden. Interview guidelines support the collection of in-depth qualitative information from various stakeholders, including students, faculty members, and campus staff. To measure user satisfaction and perceptions, standardized questionnaires are administered, enabling quantitative evaluation of user experiences. In addition, the study integrates IoT-based instruments, such as soil-moisture sensors, environmental sensors, and automated irrigation devices, to monitor ecological performance variables in real time. Interaction with plant-information content is captured through QR-code system activity logs, which provide insights into user engagement with the educational elements of the garden.

Data collection is conducted through multiple techniques, including direct field observation, semi-structured interviews, field measurements, continuous sensor logging, and

structured survey distribution. This multimethod approach ensures the triangulation of data and strengthens the validity of the findings.

The analysis process adopts both qualitative and quantitative strategies aligned with the mixed-methods research design. Qualitative data obtained from interviews and observational records are processed using thematic analysis, which involves coding, categorizing, and identifying recurring patterns related to user needs, spatial behavior, and contextual issues within the garden environment.

Quantitative data, including sensor outputs and questionnaire responses, are analyzed through descriptive statistical techniques - such as mean, percentage distribution, and trend analysis - to evaluate system performance indicators and levels of user satisfaction. Comparative analysis is also conducted to examine changes before and after the implementation of the revitalization measures. All analytical procedures are interpreted in relation to the stated research aims, with a focus on assessing improvements in ecological performance, social usability, and the educational value contributed by the smart eco-park design.

RESULTS AND DISCUSSION

Site Analysis Results and Fundamental Design Concept

The site analysis identified three primary issues forming the basis for the garden revitalization design: (1) the limited communal function of the space as an interaction area for the academic community, (2) the unstructured utilization of flora that does not yet reflect the ecological role of the garden, and (3) the lack of technological integration in monitoring and management systems. These findings were derived from field observations, stakeholder interviews, and a review of previous planning documents. Topographic measurements using a Total Station (Figure 2) indicate that the garden area has an uneven contour, forming longitudinal slopes in several sections. This condition suggests the need for an adaptive design approach to ensure that the open space meets the principles of being accessible, safe, and comfortable, as recommended in public space design guidelines [5,6]. The dynamic topography also necessitates strategies for circulation redesign, strengthened accessibility, and landscape elements capable of accommodating elevation variations.

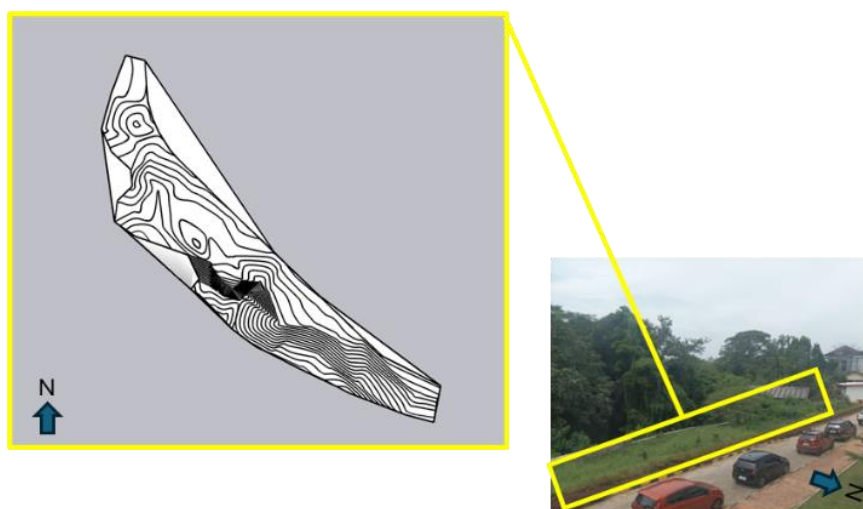


Figure 2. Current Land Contour Conditions.

Based on these findings, the main design concept formulated is “The Flowing Innovation Park.” This concept was developed in response to the site's flowing topographic characteristics by incorporating organic, curved lines into paving elements and applying terraced forms to represent natural topographic flow. This organic design approach not only enhances the visual identity of the garden but also supports a more dynamic and intuitive user circulation pattern (Figure 3). Such circulation patterns are intended to promote more active and inclusive social interactions within the open space. The Flowing Innovation Park concept is further oriented toward transforming the garden into a smart eco-park, an open campus space that integrates ecological sustainability, social comfort, and smart technologies as key supporting components. Integration of technological elements - such as smart irrigation systems, environmental sensors, and QR-based information media - is expected to enhance management efficiency and strengthen the educational function of the garden. Thus, the resulting design not only addresses the previously identified management and environmental issues but also establishes an innovative, future-oriented model of an academic communal space [7-9].



Figure 3. Landscape Site Plan of the FST Garden.

Design of the Open Communal Space and Circulation

The design (Figure 4) prioritizes the creation of an open communal area through the development of a tiered amphitheater that strategically utilizes the elevation differences identified in the contour analysis. The amphitheater is conceived as a flexible space capable of accommodating various academic and social activities, including field lectures, art performances, and scientific discussions. This aligns with the established function of Green Open Spaces (RTH) as facilitators of social interaction and environmental learning [8,10].



Figure 4. Tiered Amphitheater Design as an Open Communal Space.

Within the context of campus planning, the proposed design reflects an interdisciplinary integration of architecture, landscape architecture, and urban design, aimed at developing multifunctional and high-utility outdoor spaces [11]. Curvilinear pedestrian pathways, integrated with contour steps, are configured to ensure unobstructed and accessible circulation, while enhancing both physical and psychological user comfort.

Furthermore, the adaptive circulation system designed to follow the site's natural topography contributes to the criteria of a resilient and healing campus environment [12]. By optimizing existing land contours, the design minimizes large-scale cut-and-fill operations, thereby reducing environmental impact and construction costs. The flowing circulation pattern, converging toward the Open Theatre (Tiered Amphitheater) as the primary communal node, is intended to encourage spontaneous interaction and accommodate diverse user activities [13].

Functional Analysis of Shading Structures (Gazebo and Pergola)

The presence of the gazebo and wooden pavilion (Figure 5) serves dual functions: providing semi-private spaces and facilitating social interaction within the garden area. These roofed structures play a significant role in offering thermal and visual comfort by providing protection from tropical climatic conditions. Consequently, they enhance the duration and quality of outdoor activities [14]. The linear pergola structure serves not only as a visually prominent architectural element but also as an ecological component that supports climbing vegetation. As a shading element, it creates a rhythmic and comfortable walkway, enriching both landscape aesthetics and circulation. The pergola's design anticipates user behavior and patterns of social interaction in campus outdoor spaces.



Figure 5. (a) Gazebo Design; (b) Wooden Pavilion Pergola Design.

Overall, the integration of hardscape and softscape elements, including shading structures, is guided by principles of sustainability. The selection of wood material for the gazebo and pavilion reflects the application of local wisdom and supports environmentally responsive design [15]. Additionally, the pergola's ecological function contributes to mitigating micro-temperature increases during daytime hours, in alignment with Green Campus principles emphasizing environmental quality enhancement and passive energy efficiency.

Utilization of Local Flora as Educational Media

The design and physical development of the garden explicitly integrate prominent local flora from Jambi (Figure 6). Selected species include Red Palm, Taro, and Pitcher Plant. The use of local flora represents a fundamental approach in sustainable landscape design, as it

reinforces ecological and cultural identity while ensuring high plant adaptability to the regional climate [10]. Moreover, local plant species hold strategic value as learning resources in biology and ethnobotany, supporting contextual learning within an academic environment [1]. Planned vegetation arrangements along pedestrian paths and planting beds strengthen the educational role of the garden, establishing it as a living laboratory consistent with the research goal of creating an interdisciplinary learning medium.



Figure 6. (a, b) Garden Design Integrating Jambi's Local Flora.

The ethnobotanical approach embedded in the garden design serves a dual purpose: promoting biodiversity conservation and reinforcing local cultural values. The integration of local plant species supports the preservation of medicinal plants and regionally significant commodities, while enhancing the garden's function as an educational resource that cultivates environmental awareness and botanical literacy among the academic community [13]. Thus, embedding local wisdom through landscape interpretation in public campus spaces becomes essential in maintaining a harmonious relationship among culture, nature, and education.

Implementation of Technology for Sustainable Management

The integration of a Smart Irrigation System (SIS) connected to soil-moisture sensors constitutes a key component of the innovative smart eco-park concept. The implementation of this intelligent system aims to improve water-use efficiency and reduce operational costs associated with garden maintenance [7]. Sensors monitor environmental factors in real time, enabling proactive and resource-efficient management. Additionally, the installation of digital information media (QR Codes) on local flora enhances interactive learning and improves accessibility to botanical information, thereby reinforcing the garden's function as a digital-supported educational and research platform.

CONCLUSIONS

The revitalization of the FST UNJA garden demonstrates how an integrated, interdisciplinary approach can effectively transform an underutilized campus open space into a functional, ecological, and interactive smart eco-park. The site analysis identified three primary issues - limited communal functionality, unstructured use of local flora, and the absence of technological integration - which became the basis for developing the overarching design concept "The Flowing Innovation Park." This concept successfully responds to the site's topographic constraints through adaptive landscape strategies, the application of organic circulation patterns, and the incorporation of terraced forms that enhance accessibility, safety, and comfort.

The implementation results indicate improvements in ecological performance, environmental readability, and the quality of social interactions within the garden. Sensor data demonstrated more efficient water usage and healthier soil moisture levels, while user evaluations showed increased satisfaction, comfort, and engagement with outdoor campus spaces. The revitalized garden thus aligns with contemporary frameworks for sustainable campus landscape design, ecological resilience, and smart public-space management.

Overall, the revitalization project successfully demonstrates how sustainable design, ecological principles, and smart technologies can be synergized to enhance campus environments, contributing to a more resilient, interactive, and educational landscape for the academic community.

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AUTHOR CONTRIBUTIONS

Conceptualization, Mahya Ihsan and Bambang Hariyadi; Methodology, Mahya Ihsan; Software, Andre Rabiula; Validation, Mahya Ihsan, Bambang Hariyadi, and Fetty Febriasti Bahar; Formal Analysis, Nurza Purwa Abiyoga; Investigation, Fetty Febriasti Bahar; Resources, Mahya Ihsan; Data Curation, M. Nuklirullah; Writing - Original Draft Preparation, Nurza Purwa Abiyoga; Writing - Review & Editing, Fetty Febriasti Bahar; Visualization, Andre Rabiula; Supervision, Bambang Hariyadi; Project Administration, Nurza Purwa Abiyoga; Funding Acquisition, Bambang Hariyadi.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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DECLARATION OF ARTIFICIAL INTELLIGENCE USE

AI-based language tools were used only for manuscript formatting support, language refinement, and reference-style adjustment during editorial preparation. We confirm that all AI-assisted processes were critically reviewed to ensure the integrity and reliability of the manuscript. The final decisions and interpretations presented in this article remain the sole responsibility of the authors.

REFERENCES

1. Kaswanto RL. Rekomendasi strategi pengelolaan lanskap publik ruang terbuka hijau dan biru di Kota Bogor. *Risalah Kebijakan Pertanian dan Lingkungan*. 2024;11(2):102-112.
2. Sinaga AS, Sinurat A, Saragih H. Zonasi ruang terbuka hijau dalam mendukung pengelolaan lingkungan perkotaan yang berkelanjutan. *PESHUM: Jurnal Pendidikan, Sosial dan Humaniora*. 2025;4(2):2257-2264.
3. Hartabela D, Anggraini H, Vidyana C, Bahar FF, Pratiwi RA, Maulidiah S, et al. Unsur-unsur kenyamanan ruang terbuka perkotaan. Medan: Yayasan Kita Menulis; 2024.
4. Mansyur J, Ali MS, Simarmata MM, Pratomo S, Hutriani IW, Ritnawati R, et al. Ekologi taman kota: Fungsi dan peranannya. Medan: Yayasan Kita Menulis; 2025.
5. Kühn S, Schmalen K, Beijers R, Tyborowska A, Roelofs K, de Weerth C. Green is not the same as green: differentiating the association of trees and open green spaces with children's brain structure in the Netherlands. *Environment and Behavior*. 2023;55(5):311-333.
6. Jiangjiang S, et al. Evaluation study on the smart and interactive landscape design of Haiyuntai Waterfront Park from the perspective of a sustainable city. *ISPRS International Journal of Geo-Information*. 2025;14(2):357. doi:10.3390/ijgi14020357.
7. Huldiansyah D, Dewi TR, Jordan NA. Rancangan lansekap gedung kuliah E kampus Institut Teknologi Kalimantan sebagai ruang multi fungsi. *JATUR (Journal of Architecture and Urbanism Research)*. 2022;5(2):109-120.
8. Mt Akhir N, et al. Landscape spatial character: students' preference on outdoor campus spaces. *Asian Journal of Quality of Life*. 2018;3(13):89-97.
9. Syaifuddin S, et al. Potensi tumbuhan lokal sebagai sumber belajar biologi. *Prosiding Seminar Nasional Pendidikan Biologi*. 2014;1(1):164-173.
10. GovPilot. Designing smart parks: blending urban nature with technology. GovPilot Blog. 2023.
11. Lesmana TS, Pratiwi RA. Perencanaan lanskap kampus ITERA untuk menciptakan ruang ekosistem yang lenting dan menyembuhkan. *Arsitekta: Jurnal Arsitektur dan Kota Berkelanjutan*. 2024;6(2):77-88.
12. Raka P, Utomo D. Evaluasi elemen lanskap pada Taman Inspirasi Undip sebagai taman aktif. *IMAJI*. 2025;3(2):66-76.
13. Handryawan Y, Setiawan P. Konsep arsitektur lanskap berkelanjutan pada desain taman. *PAWON: Jurnal Arsitektur*. 2023;7(1):95-107.
14. Al Ayyubi MS, Arifin HS, Kaswanto RL. Rekomendasi strategi pengelolaan lanskap publik ruang terbuka hijau dan biru di Kota Bogor. *Risalah Kebijakan Pertanian dan Lingkungan: Rumusan Kajian Strategis Bidang Pertanian dan Lingkungan*. 2024;11(2):102-112.
15. Farhan FM, Hidayati R. Evaluasi fungsi taman kampus Universitas Pendidikan Indonesia sebagai ruang open space kampus. In: *Prosiding Seminar Ilmiah Arsitektur (SIAR)*; 2023 Jul 20. p. 724-733.