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Bamboo Species Database and Geotagging System with Decision Support System

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Abstract:
Bamboo resources in Cagayan Province, Philippines, face challenges such as fragmented data, inconsistent protocols, and inadequate management, hindering sustainable utilization and conservation efforts. This study developed the Bamboo Species Database and Geotagging with Decision Support Features (BSDG-DSS) to address these issues. Combining descriptive and developmental research, the system integrates species profiling, GPS-based geotagging, and decision-support tools to enhance resource management and stakeholder collaboration. Evaluated against ISO 25010:2015 Software Quality Standards, the system achieved high compliance in functionality, usability, security, and reliability. Key features include species morphological, phytochemical, and genetic profiling, geospatial mapping, and interactive decision-support reports. Challenges such as resource constraints and data inconsistencies were identified, and enhancements like role-based access control, responsive web design, and mobile applications were proposed. The BSDG-DSS highlights the transformative potential of technology in resource management, fostering sustainable bamboo utilization, conservation, and economic growth. This study provides a scalable solution for addressing similar resource management challenges in other regions.

Keywords: Bamboo species database, geotagging, decision support system, GIS, ISO 25010:2015 standards, bamboo resource management, sustainable development

INTRODUCTION

Bamboo is a versatile resource with critical ecological, economic, and social significance, particularly in tropical regions like the Philippines. It is essential for environmental conservation, rural livelihoods, and economic development. However, bamboo resource management in the Cagayan Province is hindered by fragmented data, lack of geospatial mapping, and inconsistent resource documentation protocols [1][2]. These challenges result in inefficient conservation efforts and hinder sustainable bamboo utilization. A comprehensive technological solution integrating species profiling, geospatial mapping, and decision-support tools is necessary to address these gaps. This study developed the Bamboo Species Database and Geotagging with Decision Support System (BSDG-DSS) to provide stakeholders with accurate and actionable data for effective bamboo resource management. By adhering to ISO 25010:2015 Software Quality Standards, the system ensures robust performance, reliability, and usability, laying the groundwork for informed decision-making and sustainable practices [3].

METHODS

The study employed a mixed-method approach, combining descriptive and developmental research desi-

gns. The descriptive component identified challenges in bamboo resource management and documented stakeholder requirements through interviews with bamboo growers, researchers, and DENR experts [4][5]. Questionnaires were administered to evaluate the system against ISO 25010:2015 Software Quality Standards, focusing on key metrics such as Functional Suitability, Performance Efficiency, and Usability [3]. On-site surveys using GPS technology were conducted to geotag bamboo species and gather spatial data [6]. Secondary data on bamboo characteristics and distributions were integrated to ensure a comprehensive dataset [7].

Development Framework

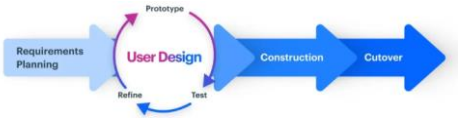

Fig. 1. Throwaway Prototyping Rapid Application Development Model.

The system was developed using the Throwaway Prototyping Rapid Application Development Model. This included requirements planning to define the system's scope and technical constraints, user design involving iterative prototyping and feedback loops, rapid construction of functional modules, and final deployment with user training [8][9].

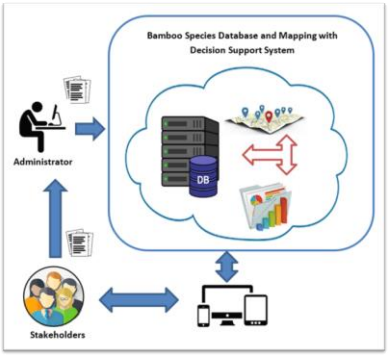

Fig. 2. System Architecture

The system's architecture featured a web-based client-server design, integrating GPS geotagging, species profiling modules, and decision-support tools. Evaluations followed ISO 25010:2015 standards, assessing compliance across eight quality attributes to validate system performance and scalability [3][10].

RESULTS

The study revealed significant challenges in bamboo resource management, including fragmented and inconsistent data sources, lack of standardized geotagging protocols, and resource constraints affecting data collection and validation [2][4][11]. Stakeholder collaboration was limited by communication gaps and varying objectives among government agencies, researchers, and growers [5][7]. These challenges underscored the need for a centralized database and harmonized protocols.

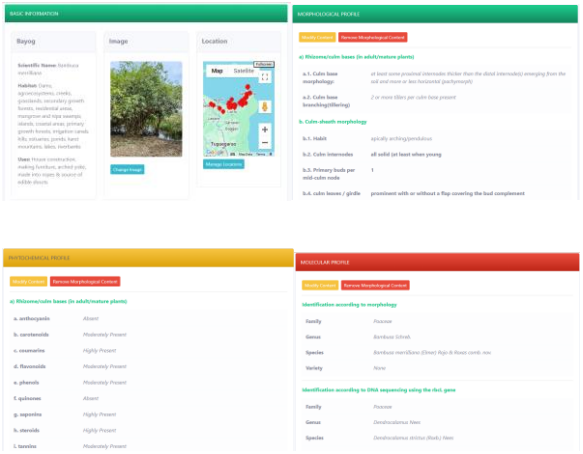

Fig. 3. Sample Bamboo Profile

The BSDG-DSS addressed these challenges by providing comprehensive species profiling modules that documented morphological, phytochemical, and genetic characteristics of bamboo species [6][9]. The geospatial mapping feature used GPS technology to accurately map bamboo distribution, enabling habitat suitability assessments and conservation planning [12].

Fig. 4. Decision Support Reports

Integrated decision-support tools facilitated data-driven decision-making by generating reports on species applications, population density, and economic potential [3]. The system achieved a Very Great Extent of Compliance with ISO 25010:2015 standards, with an overall score of 4.56, reflecting its functionality, usability, security, and reliability [3][10]. Proposed enhancements included implementing role-based access controls, responsive web design, and a mobile application for field data collection to improve user experience and system scalability [13].

DISCUSSION

The BSDG-DSS demonstrated the transformative potential of integrating ICT tools in natural resource management. The system addressed critical gaps in data accessibility, standardization, and stakeholder collaboration, enabling efficient and sustainable bamboo resource management [4][5]. High compliance with ISO 25010:2015 standards validated the system's robustness and usability, ensuring its effectiveness in supporting diverse stakeholder needs [3][10]. Despite its success, challenges such as data inconsistencies and limited technical resources highlighted the need for further capacity building and stakeholder training [7][12]. While GPS-based geotagging was effective for mapping, hybrid approaches, such as LiDAR and advanced GIS techniques, could enhance mapping accuracy in dense forest ecosystems [6][14]. Future research should focus on predictive analytics to forecast resource trends and integrate climate models to evaluate habitat suitability under changing environmental conditions [8][13]. Expanding the system's geographic scope and enhancing its scalability will further strengthen its relevance for regional and national bamboo resource management initiatives [11][14].

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