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PROJECT MONITORING AND EVALUATION USING GEOGRAPHIC INFORMATION SYSTEM (GIS) TECHNOLOGY: A CASE STUDY OF THE CONSTRUCTION OF THE FLOOD CONTROL STRUCTURE ALONG THE PRINCIPE RIVER, AGOO, LA UNION, PHILIPPINES

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ABSTRACT----------
The case study examines the application of Geographic Information System (GIS) technology in the monitoring and evaluation of the construction of the flood control structure along the Principe River in Agoo, La Union, Philippines. The study explores how GIS contributes to improved project monitoring, resource allocation, environmental compliance, and risk management. Using tools such as ArcGIS and QGIS, GIS provided real-time visualization and site condition analysis that supported efficient decision-making and project implementation. Findings indicate that GIS enhanced resource utilization by identifying priority reinforcement zones and contributed to environmental sustainability by identifying ecologically sensitive areas. GIS also assisted in meeting project milestones by anticipating potential delays and supporting alternative workflow adjustments. However, high implementation costs and limited technical expertise were identified as constraints, underscoring the need for capacity building and cost-efficient GIS solutions. The study employed a qualitative descriptive case study design, utilizing structured interviews and field observations with project engineers and GIS specialists involved in the project implementation. The findings highlight the transformative potential of GIS technology in infrastructure development, particularly in enhancing implementation efficiency, regulatory compliance, and risk mitigation in flood-prone areas.

KEYWORDS: *GIS Technology, Monitoring, Evaluation, Flood Control, Infrastructure Management*

INTRODUCTION

Project monitoring and evaluation constitute critical components of construction project implementation, as they ensure that project objectives are achieved within defined quality, cost, and time parameters. Monitoring documents project progress relative to planned targets, while evaluation assesses the degree to which outcomes are achieved and identifies factors influencing performance. Together, these processes support informed decision-making, reinforce accountability, and promote timely identification of implementation challenges that may affect project delivery.

In recent years, Geographic Information System (GIS) technology has emerged as a valuable tool in strengthening project monitoring and evaluation, particularly in large-scale and environmentally sensitive infrastructure projects. GIS enables the collection, integration, visualization, and analysis of spatial and non-spatial data, thereby allowing project managers to assess environmental conditions, terrain features, and construction progress in real time. Such capacities are especially relevant in flood control projects, where terrain morphology, hydrological behavior, and site stability are essential considerations in ensuring structural performance and environmental compatibility.

Within the context of the construction of the flood control structure along the Principe River in Agoo, La Union, GIS technology served as an integral support tool in monitoring project implementation. By overlaying project plans with geospatial data and real-time site observations, GIS facilitated more responsive decision-making, improved resource allocation, and enhanced adherence to project timelines and performance standards. Moreover, its application contributed to the identification of high-risk and environmentally sensitive areas, enabling proactive mitigation of potential hazards associated with flooding, erosion, and site instability.

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Given the increasing relevance of GIS in infrastructure development, particularly in flood-prone areas, this case study examines the application of GIS technology in the monitoring and evaluation of the Principe River flood control project. The study highlights how GIS contributed to project efficiency, risk management, and environmental compliance, and provides empirical insights into its role as a decision-support tool in construction project implementation.

Review of Related Literature

Geographic Information System (GIS) technology has increasingly been recognized as a vital support tool in project monitoring and evaluation, particularly in infrastructure and flood control projects. By integrating spatial and non-spatial datasets, GIS enables spatial visualization, terrain assessment, and data-informed decision-making across project phases, contributing to improved implementation efficiency and reduced resource wastage (Radwan et al., 2020). In flood management contexts, GIS has been used to identify hazard-prone areas, support hydrological modeling, and assess environmental impacts, thereby strengthening structural design and adaptive planning (Burrough & McDonnell, 1998; Chow et al., 1988; Maidment, 1993). Development institutions similarly emphasize the value of GIS-enabled monitoring in promoting regulatory compliance and evidence-based evaluation in disaster-risk and infrastructure programs (World Bank, 2016; Zhou et al., 2021).

Advances in spatial data infrastructure and remote sensing have further enhanced GIS functionality through interoperable datasets and high-resolution terrain imagery, improving river morphology assessment and environmental monitoring (Williamson et al., 2003; Campbell & Wynne, 2011). Widely used GIS platforms such as ArcGIS and QGIS support terrain modeling, spatial analytics, and construction progress mapping, offering both advanced geoprocessing capabilities and cost-efficient open-source alternatives. Empirical applications across diverse flood control initiatives—including projects in Southeast Asia and major river systems—demonstrate GIS contributions to risk identification, resource planning, and post-implementation evaluation (Hoanh et al., 2010; White, 2005; David et al., 2019).

Nevertheless, challenges persist in terms of implementation cost, technical capacity, and data compatibility, underscoring the need for capacity building and broader institutional integration of GIS tools. Overall, the literature indicates that GIS serves as an effective decision-support and monitoring technology in environmentally sensitive and flood-prone project environments, providing a relevant foundation for examining its application in the Principe River flood control project.

METHODOLOGY

Research Design

This study employed a descriptive case study design focusing on the construction of the flood control structure along the Principe River in Agoo, La Union. GIS technology, specifically ArcGIS and QGIS, was incorporated into project monitoring and evaluation to document its functional contribution to implementation efficiency, environmental assessment, and risk mitigation. The design enabled an in-depth examination of processes, application outcomes, and implementation challenges associated with GIS integration in an actual construction setting.

Respondents

The respondents of the study comprised four key project personnel who held significant roles in the implementation of the project. These included two project engineers from the Construction Unit, who supervised construction activities and ensured compliance with approved plans, technical specifications, and prescribed timelines; and two GIS specialists from the Planning, Design, and Flood Control Unit, who managed geographic data, prepared spatial maps, and utilized GIS tools to support planning, monitoring, and decision-making. Their participation provided comprehensive insights from both operational and technical perspectives, thereby facilitating a holistic understanding of GIS application in project monitoring and evaluation.

Data Gathering Procedure

Data for this study were collected through structured interviews administered to key project stakeholders, including project engineers, project managers, and GIS specialists who were directly involved in the implementation and monitoring of the project. A structured interview guide was utilized to ensure consistency in the line of questioning and to facilitate the systematic elicitation of relevant information. The interviews primarily focused on three major areas of inquiry: the role of GIS tools, particularly ArcGIS and QGIS, in monitoring project progress; the ways in which GIS contributed to the enhancement and improvement of project monitoring and evaluation processes; and the overall impact of GIS technology on the project's success in terms of implementation

efficiency, decision-making, and risk management. The use of structured interviews ensured that the data gathered were comprehensive, comparable, and aligned with the study's research objectives.

Data Analysis

The construction of the flood control structure along the Principe River demonstrated how the application of GIS technology has substantially transformed project monitoring and evaluation processes. Data gathered from interviews and field observations revealed patterns that aligned with existing theories and practices in GIS-supported infrastructure management. GIS facilitated real-time monitoring and decision-making by enabling project managers to map construction progress and assess site conditions such as soil stability, river flow behavior, and terrain vulnerability, allowing immediate responses to site disturbances such as erosion or fluctuating water levels. In terms of resource allocation, GIS helped identify structurally critical zones requiring reinforcement, thereby guiding the precise deployment of construction materials such as concrete and steel, reducing waste, and optimizing resource utilizations supporting previous findings that GIS promotes cost efficiency and material prudence. The integration of environmental data within GIS mapping also strengthened environmental compliance and sustainability by identifying ecologically sensitive areas and ensuring that construction activities were compatible with regulatory and ecosystem requirements, consistent with globally recommended GIS-based environmental monitoring frameworks. Furthermore, GIS contributed to project timelines and risk management by detecting potential workflow barriers and supporting predictive assessments of delays caused by environmental or weather-related factors, which enabled proactive schedule adjustments and improved milestone adherence. Despite these benefits, several barriers to GIS implementation were identified, including high software and operational costs, along with limited technical expertise in the local context, highlighting the need for continuous capacity building, standardized training, and the adoption of more cost-efficient GIS solutions to further maximize its potential in infrastructure project monitoring and evaluation.

RESULTS AND DISCUSSION

The findings of this case study provided a detailed examination of the role and effectiveness of GIS technology in the construction of the flood control structure along the Principe River in Agoo, La Union. GIS played a central role in project monitoring and evaluation by enabling real-time visualization of construction progress and clearly indicating completed and pending work areas, thereby supporting timely project updates and facilitating strategic resource allocation to priority zones. It also aided in assessing site conditions during construction, particularly in relation to soil instability and irregular river flow patterns. In terms of process improvement, GIS functioned as a visual monitoring tool that helped maintain project timelines and milestone completion, while also enhancing adaptability to environmental variations through flood risk mapping and weather impact forecasting, which enabled responsive adjustments to construction schedules. Overall, the use of GIS contributed significantly to project success by improving resource management, reducing redundant work, and supporting rapid, informed decision-making during critical site conditions such as adverse weather or resource disruptions. Its capacity to identify high-risk areas further strengthened risk management and ensured compliance with environmental regulations, thereby enhancing the project's efficiency, safety, and environmental sustainability.

The use of GIS in this project also carries broader theoretical and practical implications. From a monitoring and evaluation perspective, GIS improved performance tracking by providing accurate, real-time visualization of site conditions and construction progress, consistent with earlier theoretical insights on spatial data integration and the functional capabilities of ArcGIS and QGIS tools. With respect to resource allocation, GIS supported the optimal distribution of materials and labor to structurally critical areas, minimizing costs and reducing wastage, consistent with prior findings that emphasize the efficiency benefits of GIS-assisted resource planning; however, further enhancement may be achieved through continuous GIS capacity-building among project personnel. Finally, GIS played a crucial role in risk management and environmental compliance by identifying flood-prone and erosion-susceptible zones, enabling proactive mitigation strategies, and supporting adherence to environmental standards, which contributed to more sustainable and resilient project implementation. Collectively, these findings demonstrate the transformative contribution of GIS technology in improving project efficiency, strengthening risk management, and promoting environmentally responsible infrastructure development.

CONCLUSION

Overall, the study demonstrates that GIS significantly enhanced project monitoring accuracy, resource allocation efficiency, milestone adherence, and environmental risk management in the Principe River flood control project. Through real-time visualization, proactive hazard identification, and evidence-based decision-making, GIS contributed to safer, more efficient, and environmentally compliant project implementation.

GIS provided access to the visualization of projects in real-time while improving the accuracy of monitoring and evaluation processes. It also helped in saving costs, while increasing efficiency by directing materials and labor on critical zones.

Moreover, GIS helped utilize the project workflows as a visual checklist for achieving project deadlines and milestones, especially when the weather was unstable. Finally, it helped in enhancing risk management by identifying high-risk areas. Thus, it also aided in the preventive management of possible hazards such as floods and erosion, and safety during construction activities. The findings, however, are limited to a single project context; nevertheless, they provide practical insights that may guide future GIS-based infrastructure monitoring and evaluation initiatives.

RECOMMENDATIONS

Based on the findings of the study, several measures are recommended to further optimize the application of GIS technology in future infrastructure projects, particularly in strengthening monitoring, evaluation, and resource management processes. First, it is recommended that project teams be provided with continuous and advanced training in GIS applications, particularly in spatial data analysis and systems integration, to enable them to maximize the full technical and analytical benefits of the technology. Second, institutions and implementing agencies are encouraged to explore and adopt cost-efficient and budget-friendly GIS software solutions, especially in government-funded projects, to promote wider system adoption and sustainable utilization without compromising functionality. Finally, the broader institutionalization and mainstream adoption of GIS across similar infrastructure projects is recommended to improve project efficiency, strengthen resource management, and support data-driven decision-making in planning, implementation, and post-construction evaluation.

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