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IMPACT OF INNOVATIVE DESIGN APPROACHES ON PROJECT PERFORMANCE IN NATIONAL IRRIGATION ADMINISTRATION PROJECTS

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ABSTRACT

This study examined the impact of innovative design approaches on project performance in terms of efficiency and sustainability in National Irrigation Administration (NIA) projects. Specifically, it assessed innovative design approaches in terms of integration of modern technologies, eco-friendly materials, design flexibility, and stakeholder-centered planning, as well as project performance in terms of operational efficiency and environmental sustainability. A quantitative research design was employed. The respondents were 100 farmer-beneficiaries of irrigation projects in Santa Cruz, Laguna, selected through multistage sampling for representation across irrigation sites. Data were gathered using a researcher-made 4-point Likert questionnaire and analyzed using mean, standard deviation, and regression analysis. Findings revealed a very high level of innovative design approaches and project performance across all indicators. Modern technologies, eco-friendly materials, design flexibility, and stakeholder-centered planning were highly recognized as important components of NIA projects. Operational efficiency and environmental sustainability were also rated very high. However, regression analysis highlighted the relevance of innovative design approaches in relation to project performance in terms of operational efficiency and environmental sustainability. The study concluded that while innovative design approaches are highly valued, their perceived importance does not directly translate into measurable performance outcomes. Effectiveness may depend on implementation consistency and contextual conditions across project phases. It recommends strengthening institutional support, technology integration, sustainability practices, and stakeholder engagement to improve irrigation outcomes.

KEYWORDS: *Innovative Design Approaches, Operational Efficiency, Environmental Sustainability, Irrigation Projects, Stakeholder-Centered Planning, NIA*

INTRODUCTION

The agricultural sector in different parts of the world is under increasing pressure to increase productivity with minimum environmental impact. Climate change, water scarcity, and degradation of natural resources have heightened the demand for sustainable irrigation systems that would be supportive of food security and rural development. In recent years, various countries have embraced innovative design approaches for irrigation infrastructure, focusing on modern technologies, eco-friendly materials, and participatory planning to improve efficiency and resilience.

This perspective is closely aligned with the principles of Sustainable Development Theory, which emphasizes meeting present development needs without compromising the ability of future generations to meet their own needs. In the context of irrigation infrastructure, the theory highlights the importance of balancing economic productivity, environmental protection, and social well-being. Consequently, innovative design approaches in irrigation projects are increasingly viewed not only as tools for improving operational performance but also as essential strategies for achieving long-term sustainability and resilience.

Sustainable Development Theory is ensuring that current needs are met without diminishing the opportunities for future generations to meet their own aspirations. This designation requires a careful balancing act, a thoughtful consideration of the planet's finite resources and the needs of all people, both now and in the years to come. It's not just about environmentalism; it's a holistic approach that considers economic prosperity and social equity as equally significant components. The three pillars of sustainability are Environmental Sustainability, Economic Sustainability, and Social Equity. It's a call to action, urging people to rethink their approaches to development and to prioritize long-term well-being over short-term gains (Sustainability Directory, 2025).

Sustainable Development Theory of Brundtland Commission (World Commission on Environment and Development, 1987) emphasizes meeting present needs without compromising the ability of future generations to meet their own. This theory is highly applicable to the study, which investigates how innovative design approaches such as integration of modern technologies, adoption of eco-friendly materials, design flexibility and adaptability, and stakeholder-centered planning can enhance both efficiency and sustainability in National Irrigation Administration (NIA) projects. This theory supports the idea that design decisions in public infrastructure must balance technical performance with ecological and social responsibility. It validates the study's focus on how engineering innovation can drive sustainable outcomes in government-led irrigation projects.

Sustainable infrastructure development emphasizes the integration of environmental protection, economic efficiency, and social inclusivity in engineering projects. According to the United Nations Development Programme (UNDP, 2022), sustainable water

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infrastructure systems must ensure long-term resource availability while minimizing environmental degradation and maximizing community benefits.

The study entitled "Impact of Innovative Design Approaches on Project Performance in the National Irrigation Administration" is anchored on the Diffusion of Innovations Theory (DOI) by Everett M. Rogers. This theory explains how new ideas, practices, or technologies spread within an organization and how individuals adopt them over time. Rogers identifies five key attributes—relative advantage, compatibility, complexity, trialability, and observability—that influence the adoption process. By using this framework, the study seeks to examine how innovative design approaches are embraced and implemented within NIA projects.

In this context, relative advantage refers to the extent to which innovative design approaches improve efficiency, reduce costs, and enhance project quality compared to traditional methods. Compatibility assesses how well these approaches fit with existing systems, procedures, and organizational culture. Complexity evaluates the difficulty or ease with which NIA personnel can understand and apply new design strategies. Trialability considers whether these innovations can be tested on a smaller scale before full adoption, and observability examines how visible the positive outcomes of these approaches are to stakeholders, thereby encouraging wider acceptance.

Applying Rogers' theory provides a framework to analyze the relationship between innovation adoption and project performance. By understanding how NIA personnel perceive, adopt, and implement innovative design approaches, the study can identify factors that enhance or hinder project success. This theoretical lens emphasizes that project performance is not only affected by the technical merits of innovations but also by how effectively these innovations are communicated, observed, and integrated into the organizational environment.

Irrigation in the Philippines has remained important in agricultural productivity, not only for rice but equally for high-value crops. The country is still facing problems related to outdated systems, inefficient water distribution, and environmental degradation due to poorly designed infrastructure. The National Irrigation Administration is tasked as the lead agency for irrigation development in enhancing its projects to address the needs of farmers and communities. However, despite government and other related institutions' efforts and budget allocations, challenges persist in pursuing innovation and translating it into practice, especially in remote and resource-constrained areas.

Most of the irrigation projects face delays, technical limitations, and low adoption of sustainable design principles at the local level, which seriously compromise operational efficiency and long-term environmental sustainability. For many local engineers and project managers, limited technical capability, resistance by stakeholders, and a lack of universally applicable design frameworks would further constrain the ability to implement advanced solutions.

Indeed, there is a strong need to conduct an in-depth analysis of how innovative design approaches can be implemented in order to improve the performance and sustainability of NIA projects.

In light of this, the study would investigate the impacts of recent design approaches on the efficiency and sustainability of National Irrigation Administration irrigation projects, focusing on which design elements contribute most to improving operational outcomes and ensuring environmental sustainability.

Innovative Design Approaches

According to the International Commission on Irrigation and Drainage (2025), innovation in irrigation design is no longer limited to engineering efficiency; it now encompasses digital integration, ecological sensitivity, and participatory governance. The Philippine National Irrigation Master Plan (NIA, 2020) reflects this shift by promoting a holistic framework that combines smart technologies, green materials, flexible systems, and stakeholder engagement.

The Food and Agriculture Organization (FAO, 2023) underscores that innovative irrigation design must be context-sensitive, scalable, and climate-resilient. Their regional assessments show that countries adopting integrated design strategies—those that blend technical, environmental, and social dimensions—achieve better outcomes in water use efficiency and long-term sustainability. In the Philippine setting, the Asian Development Bank (2023) has supported irrigation modernization projects that incorporate these principles, particularly in climate-vulnerable provinces.

Moreover, UNEP's legislative review of the NIMP (2025) highlights the importance of embedding innovation into public infrastructure planning. It recommends that irrigation agencies adopt adaptive design standards, prioritize low-impact materials, and institutionalize stakeholder consultations as part of the project lifecycle. These recommendations align with global best practices and offer a blueprint for enhancing the performance and sustainability of irrigation systems.

Integration of Modern Technologies

The National Irrigation Administration (2020) emphasized the integration of digital tools such as geospatial mapping, automated gate controls, and remote monitoring systems in its National Irrigation Master Plan (NIMP) 2020–2030. These technologies aim to improve water delivery efficiency and reduce operational delays in irrigation projects.

Ali et al. (2025) discussed the role of smart irrigation systems using IoT sensors and real-time data analytics in enhancing water use efficiency. Their study found that automated systems significantly reduced water wastage and improved crop yields in pilot areas

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across Asia. The International Commission on Irrigation and Drainage (ICID, 2025) reported that digital transformation in irrigation management—including cloud-based platforms and AI-assisted scheduling—has become a global trend, enabling better decision-making and adaptive water governance.

Adoption of Eco-Friendly Materials

Eco-friendly materials are increasingly used in irrigation design to reduce environmental impact and promote sustainability. The NIMP (2020) advocates for the use of low-carbon concrete, recycled plastic linings, and non-toxic sealants in canal and reservoir construction. These materials help minimize ecological disruption and support long-term infrastructure resilience.

Zhang et al. (2025) explored the use of biodegradable jute fiber-reinforced composites as an alternative to conventional plastic irrigation materials. Their findings revealed that these eco-friendly materials possess suitable mechanical properties, controlled seepage performance, and biodegradability, making them viable for sustainable irrigation applications. The study further emphasized that replacing traditional plastic-based irrigation components with biodegradable materials can reduce environmental pollution, support circular economy principles, and promote long-term sustainability in agricultural water management.

Design Flexibility and Adaptability

Design flexibility is essential for irrigation systems to respond to changing environmental, agricultural, and social conditions. The NIA's modernization strategy includes modular canal systems and scalable pump configurations that allow phased implementation and adjustment based on water availability and cropping patterns (NIA, 2020).

Moyo et al. (2025) examined the adaptation of smallholder irrigation systems to climate-related extreme events through the Transforming Irrigation in Southern Africa (TISA) project. The study highlighted the importance of adaptive irrigation designs that allow system modifications based on changing environmental conditions, water availability, and agricultural demands. Findings revealed that flexible irrigation strategies enhanced system resilience, improved water management, and strengthened the capacity of irrigation infrastructure to withstand climate-related disruptions.

UNEP (2025) emphasizes the importance of resilient infrastructure in its legislative review of the NIMP, advocating for designs that can be modified in response to climate variability, soil conditions, and community needs. Flexibility in design is not only a technical requirement but also a strategic asset for long-term sustainability.

Stakeholder-Centered Planning

Stakeholder-centered planning ensures that irrigation projects reflect local needs, priorities, and capacities. The NIMP (2020) outlines a participatory framework that includes farmer consultations, LGU coordination, and feedback mechanisms throughout the project lifecycle. This approach enhances project ownership and reduces implementation delays.

UNDP (2021) emphasizes that stakeholder engagement leads to higher project acceptance and more sustainable outcomes. Their guide recommends early and continuous involvement of end-users, especially farmers and community leaders, in the design and monitoring of irrigation systems.

The Asian Development Bank (2023) reports that irrigation projects with strong stakeholder participation, particularly those involving indigenous and farming communities, demonstrate better performance in maintenance, water-use efficiency, and social equity. Inclusive planning is now recognized as a cornerstone of effective irrigation governance.

Project Performance

In the Philippines, the National Irrigation Administration (NIA) has aligned its modernization efforts with global best practices, incorporating performance-based planning, digital technologies, and environmental safeguards into its National Irrigation Master Plan (NIA, 2020). These initiatives aim not only to improve the technical and operational efficiency of irrigation projects but also to enhance their overall project performance by ensuring timely completion, cost-effectiveness, and high-quality outcomes.

According to the United Nations Environment Programme (2025), sustainable irrigation systems must be designed to withstand climate variability, minimize ecological disruption, and support long-term agricultural productivity. Such systems are expected to balance technical efficiency, environmental integrity, and operational resilience, particularly in regions prone to drought and flooding.

The International Finance Corporation (2025) further emphasizes that modern irrigation infrastructure is a key component of resilient food systems, enabling smallholder farmers to reduce reliance on unpredictable rainfall while adapting to shifting weather patterns. By integrating these performance and sustainability dimensions, NIA projects exemplify a holistic approach to achieving efficient, high-quality, and environmentally responsible irrigation development.

Operational Efficiency

Murcia (2022) conducted a non-parametric analysis of 108 communal irrigation systems in Southern Mindanao, revealing that operational efficiency varied significantly across provinces due to differences in input-output combinations and management practices. The study emphasized the need for performance benchmarking and adaptive resource allocation to improve system productivity and reduce water losses.

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The National Irrigation Master Plan (NIA, 2020) outlines performance targets and the development of a geodatabase system to optimize irrigation planning and delivery. By integrating updated estimates of irrigable areas and water demand, the plan aims to streamline operations and reduce inefficiencies in water distribution across national and communal systems.

IWA Publishing (2022) reported that stakeholder participation in irrigation management—such as involving farmers in scheduling and maintenance—significantly improves operational outcomes. Their findings showed that participatory governance led to better compliance with water schedules, reduced downtime, and more efficient use of irrigation infrastructure.

Environmental Sustainability

The International Finance Corporation (IFC, 2025) emphasized that irrigation is becoming a cornerstone of climate-resilient food systems. Their report highlighted that sustainable irrigation reduces dependence on erratic rainfall and helps smallholder farmers adapt to climate variability, thereby enhancing long-term environmental resilience.

UNEP (2025), in its legislative review of the NIMP, stressed the importance of designing irrigation systems that minimize ecological disruption. The plan promotes the use of green infrastructure, such as vegetated canals and sediment traps, to reduce runoff, protect biodiversity, and maintain soil health.

NIA (2020) also promotes environmental sustainability by encouraging the use of eco-friendly materials and nature-based solutions in irrigation design. These include low-impact construction practices and the rehabilitation of existing systems to reduce land degradation and water pollution.

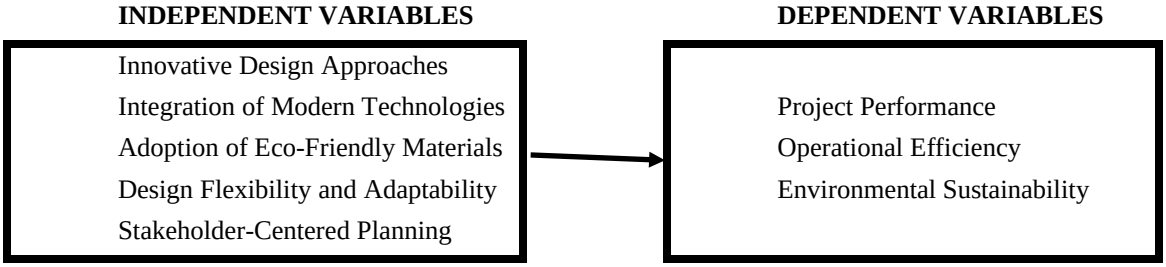

Figure 1. The Research Paradigm

The conceptual framework of this study is anchored on examining the impact of innovative design approaches on the project performance of National Irrigation Administration (NIA) projects. It seeks to determine how specific design innovations influence project outcomes, particularly in terms of operational efficiency and environmental sustainability, within public irrigation infrastructure.

The independent variable is Innovative Design Approaches, which comprises four key areas: (1) Integration of Modern Technologies, (2) Adoption of Eco-Friendly Materials, (3) Design Flexibility and Adaptability, and (4) Stakeholder-Centered Planning. These show the evolving practices in irrigation project design that aim to incorporate advanced tools, sustainable construction inputs, responsive design features, and participatory planning processes. The dependent variable is Enhanced Efficiency and Sustainability, measured through two indicators: (1) Operational Efficiency and (2) Environmental Sustainability. These outcomes serve as a foundation for evaluating the effectiveness of innovative design interventions. This framework serves as a guide for analyzing how design innovations can be strategically applied to improve the performance and sustainability of irrigation projects under the National Irrigation Administration. It shows the importance of integrating technology, materials, flexibility, and stakeholder input to achieve infrastructure solutions that are both efficient and environmentally sound.

Literature reviews and reports from institutions reviewed above form a sound basis for this study. They provide an understanding of the critical issues that surround the core variables: innovative design approaches and their importance in improving efficiency and sustainability of irrigation systems. More specifically, these relevant and reliable sources centered on how modern technologies act as an enabler of improved operational efficiency. These also emphasized the need for eco-friendly materials and nature-based solutions that can minimize environmental impact while advancing long-term resilience. The literature also highlights the importance of flexibility and adaptability in design for responses to climate variability, changing agricultural needs, and specific site conditions. Of particular note is the inclusion of stakeholder-driven planning, which has also been proven to enhance project ownership and reduce delays at the implementation phase, besides aligning infrastructure with community needs.

Statement of the Problem

All of these highlight the need to conduct a study in the local setting to understand the impact of innovative design approaches on enhanced efficiency and sustainability in National Irrigation Administration projects. Specifically, the study sought answers to the following objectives:

1. The level of implementation of innovative design approaches in terms of:
   1.1 Integration of Modern Technologies,
   1.2 Adoption of Eco-Friendly Materials,
   1.3 Design Flexibility and Adaptability, and

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1.4 Stakeholder-Centered Planning.
2. The level of Project Performance in terms of:
2.1 Operational Efficiency and
2.2 Environmental Sustainability.
3. The significant effect of innovative design approaches on the project performance of National Irrigation Administration projects.
4. The output that would enhance efficiency and sustainability in National Irrigation Administration projects through innovative design approaches.

METHODOLOGY

This study employed a quantitative research design to examine the impact of innovative design approaches on the project performance of National Irrigation Administration projects. This research design was well-suited to the study because it enabled the systematic collection and statistical analysis of numerical data to determine relationships among variables. Specifically, it enabled the measurement of how design innovations, such as the integration of modern technologies, the adoption of eco-friendly materials, design flexibility and adaptability, and stakeholder-centered planning, influenced operational efficiency and environmental sustainability within irrigation infrastructure projects.

Saunders et.al. (2020) describe quantitative research as a deductive process that begins with a theory or hypothesis and uses structured methods to test it. They emphasize its strength in producing reliable, replicable results, especially in fields such as business, engineering, and public administration.

Neuman (2022) further explains that quantitative research is ideal for identifying cause-and-effect relationships and for studies that require precise measurement of variables. It is often associated with positivist paradigms, where reality is seen as objective and measurable.

Respondents of the Study

To determine the appropriate number of participants for this study, a G*Power analysis was conducted for a multiple regression involving four independent variables and two dependent variables. Using a medium effect size ($f^2 = 0.15$), a statistical power of 0.80, and a significance level of $\alpha = 0.05$, the analysis indicated that a minimum of 95 respondents is required. This sample size ensures that the study can detect meaningful relationships with sufficient statistical reliability. From a total population of 1875, at least 100 farmers were included to meet the analytical requirements.

The respondents comprised 100 farmers who were beneficiaries of irrigation projects administered by the National Irrigation Administration (NIA). Participants were selected using a multistage sampling technique to ensure adequate representation from different project areas. In the first stage, selected irrigation service areas or project sites were identified. In the second stage, eligible farmer-beneficiaries from the selected areas were listed and screened based on the study's inclusion criteria. Finally, respondents were chosen from the identified participants to ensure a representative sample of farmers involved in or affected by NIA irrigation projects.

Strata	Population	Proportion	No. of Respondents (Sample Size)
Stage 1: Municipality			
Santa Cruz, Laguna	1,875	100%	100
Total	1,875	100%	100
Stage 2: Barangay			
Palasan	500	26.7%	27
Patimbao	400	21.3%	21
San Juan	300	16%	16
San Jose	675	36%	36
Total	1,875	100%	100

Data Gathering Procedures

The researcher used a researcher-developed questionnaire to assess the impact of innovative design approaches on project performance in National Irrigation Administration projects. The questionnaire employed a 4-point Likert scale, in which respondents rated their responses from Strongly Agree to Strongly Disagree, to gather data on their perceptions of the importance of innovative design approaches in improving the efficiency and sustainability of irrigation projects.

Cronbach's alpha was used to assess the instrument's reliability by evaluating the internal consistency of the questionnaire items. In addition, the researcher conducted a pilot test with a small group of respondents who were not included in the final sample.

The questionnaire consisted of two major parts, with each variable containing ten items. The first section focused on innovative design approaches, specifically the integration of modern technologies, the adoption of eco-friendly materials, design flexibility and

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adaptability, and stakeholder-centered planning. The second section focused on project performance in terms of operational efficiency and environmental sustainability.

To establish the reliability of the research instrument, a pilot test was conducted with respondents not included in the actual study. The internal consistency of the questionnaire was assessed using Cronbach's alpha. According to accepted reliability standards, Cronbach's alpha values ranging from 0.70 to 0.89 indicate good internal consistency, suggesting that the items consistently measure the intended constructs.

The table below presents the reliability coefficients obtained for each variable included in the study.

Variables	No. of Items	Cronbach's Alpha	Interpretation
Integration of Modern Technologies	10	0.737	Good
Adoption of Eco-Friendly Materials	10	0.768	Good
Design Flexibility and Adaptability	10	0.768	Good
Stakeholder-Centered Planning	10	0.718	Good
Project Performance	10	0.794	Good

The results revealed that the Cronbach's alpha coefficients ranged from 0.718 to 0.794, indicating good internal consistency among the questionnaire items. The highest reliability coefficient was obtained by Project Performance ($\alpha = 0.794$), suggesting that the items measuring operational efficiency and environmental sustainability consistently assessed the intended construct.

Similarly, the adoption of Eco-Friendly Materials and Design Flexibility and Adaptability both obtained a reliability coefficient of 0.768, indicating that the items under these dimensions were highly consistent. Integration of Modern Technologies obtained a coefficient of 0.737, while Stakeholder-Centered Planning recorded the lowest coefficient at 0.718. However, both values still fall within the acceptable range for good reliability.

Overall, the obtained Cronbach's alpha values indicate that the research instrument possessed satisfactory internal consistency and reliability. Therefore, the questionnaire was considered appropriate and reliable for the actual conduct of the study.0

Data Analysis

The responses obtained from the administered questionnaire were systematically processed and analyzed using IBM-SPSS version 25. The statistical procedures used in this study were carefully selected to provide reliable estimates of the extent to which innovative design approaches influence efficiency and sustainability in National Irrigation Administration (NIA) projects.

To assess the level of implementation of innovative design approaches, the study employed weighted mean and standard deviation as descriptive statistical tools. The data were interpreted using the following scale: 3.26–4.00 (Very High/Strongly Agree), 2.51–3.25 (High/Agree), 1.76–2.50 (Low/Disagree), and 1.00–1.75 (Very Low/Strongly Disagree). These statistical measures were applied across four core dimensions of innovative design approaches: (1) integration of modern technologies, (2) adoption of eco-friendly materials, (3) design flexibility and adaptability, and (4) stakeholder-centered planning.

Weighted mean and standard deviation were likewise used to assess the level of project performance, the dependent variable of the study. Project performance was measured through two key dimensions: (1) operational efficiency and (2) environmental sustainability. The same interpretation scale was used in analyzing respondents' assessments of these dimensions.

Moreover, the study applied linear regression analysis to establish the predictive relationship between the independent and dependent variables. This inferential method was used to determine whether the level of innovative design approaches significantly influences the degree of efficiency and sustainability achieved in irrigation projects. Through this analysis, the study would identify which specific innovative design elements have the strongest influence on operational and environmental performance.

RESULTS AND DISCUSSIONS

Regression Coefficients on the effect of Innovative design Approaches for Project Performance

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Decision	Interpretation
	B	Std. Error	Beta				
(Constant)	2.761	.454		6.087	<.001		
Integration of Modern Technologies Mean	.070	.062	.114	1.134	.260	Failed to Reject Ho	Not Significant
Adoption of Eco-Friendly Materials Mean	.120	.062	.197	1.934	.056	Failed to Reject Ho	Not Significant

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Design Flexibility and Adaptability Mean	.008	.065	.013	.127	.899	Failed to Reject Ho	Not Significant
Stakeholder-Centered Planning	.047	.065	.076	.728	.469	Failed to Reject Ho	Not Significant

Dependent Variable: Project Performance Overall Mean
R2= .052; F(4,95)=1.302,p=.275
Predictors: (Constant), Stakeholder-Centered Planning, Integration of Modern Technologies Mean, Adoption of Eco-Friendly Materials Mean, Design Flexibility and Adaptability Mean

Table 3 presents the regression analysis examining the effect of innovative design approaches on project performance, specifically enhanced efficiency and sustainability, in National Irrigation Administration (NIA) projects. The results revealed that the overall regression model was not statistically significant, $F(4, 95) = 1.30$, $p = .275$, with an R^2 value of .052. This indicates that the four dimensions of innovative design approaches collectively explained only 5.2% of the variance in project performance. The findings suggest that although innovative design practices are widely implemented in NIA projects, they do not significantly predict overall project performance in the present study.

Specifically, integration of modern technologies did not significantly influence project performance ($B = 0.070$, $\beta = .114$, $t = 1.13$, $p = .260$). This implies that while digital tools, automation, and technological systems are extensively adopted in irrigation projects, their direct contribution to overall project performance may not yet be sufficiently observable or may depend on other organizational and operational factors. Similarly, adoption of eco-friendly materials showed no significant effect on project performance ($B = 0.120$, $\beta = .197$, $t = 1.93$, $p = .056$), although it obtained the highest standardized coefficient among the predictors and approached statistical significance. This finding may indicate that environmentally sustainable materials contribute positively to project outcomes, but their impact may still require stronger institutional support, broader implementation, or a longer period to become fully evident.

Likewise, design flexibility and adaptability did not significantly affect project performance ($B = 0.008$, $\beta = .013$, $t = 0.13$, $p = .899$). This result suggests that although adaptable and flexible irrigation designs are highly practiced, these features alone may not directly translate into measurable improvements in overall project performance. Similarly, stakeholder-centered planning was found to have no significant influence on project performance ($B = 0.047$, $\beta = .076$, $t = 0.73$, $p = .469$). This may imply that while participatory planning and stakeholder engagement are important components of project implementation, their direct effect on efficiency and sustainability outcomes may be mediated by other administrative, technical, or contextual factors.

Overall, the regression results indicate that the identified innovative design approaches, though evident in NIA projects, were not significant predictors of project performance in this study. The findings suggest that other variables not included in the model, such as funding adequacy, institutional capacity, leadership effectiveness, policy implementation, technical expertise, and external environmental conditions, may play a more substantial role in influencing project performance. Nevertheless, the consistently high descriptive ratings of the innovative design approaches imply that these practices remain valuable in supporting sustainable and efficient irrigation management, even if their statistical influence on project performance was not established in the present analysis.

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AI Declaration

The researchers used Grammarly Pro as an AI-assisted language editing tool during the preparation of this manuscript. Its use was limited to correcting grammatical errors, improving sentence structures, and enhancing readability. The conceptualization of the study, data collection, interpretation of findings, and writing of the substantive content were performed by the researchers. All AI-generated suggestions were critically reviewed before incorporation into the final document.