EFFECT OF PROJECT PLANNING PRACTICES ON THE SUCCESS OF NASHO SOLAR-POWERED IRRIGATION PROJECT IN KIREHE DISTRICT

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Abstract
The study assessed the effect of project planning practices on the success of the Nasho Solar-Powered Irrigation Project in Kirehe District, Rwanda. A descriptive research design was used with 150 respondents comprising project staff, government officials, and beneficiaries. Data were collected through structured questionnaires and document review, while stratified random sampling ensured representation of stakeholder groups. The study was guided by Goal-Setting Theory, Resource-Based View Theory, and Risk Management Theory. The findings showed that scope planning significantly improved milestone achievement through clear objectives, proper documentation, and effective use of the Work Breakdown Structure. Resource planning enhanced cost control through proper budgeting, procurement scheduling, and efficient resource allocation. Risk management planning significantly improved timely completion of project deliverables through risk identification, monitoring, and mitigation. Overall, project planning practices had a significant effect on project success, with the model explaining 97.8% of the variation in project success. The study recommends strengthening project planning, improving resource management, and adopting proactive risk management strategies to enhance the performance and sustainability of large-scale infrastructure projects in Rwanda.

Keywords: Project Planning Practices; Scope Planning; Resource Planning; Risk Management Planning; Project Success; Solar-Powered Irrigation

1. Introduction

Agriculture remains one of the most fundamental sectors globally, sustaining livelihoods, ensuring food security, and driving economic growth in both developed and developing countries. It is estimated that agriculture employs over 27% of the world's labor force and provides food for over 7.9 billion people globally. However, the productivity of agricultural projects varies widely, largely influenced by the effectiveness of project planning practices such as cost management, scheduling, resource allocation, and stakeholder engagement. With the increasing global emphasis on climate-smart agriculture and sustainable practices, solar-powered irrigation systems have emerged as critical technologies to improve water use efficiency and promote year-round farming. Effective project planning for such initiatives is essential for their successful implementation and operational performance. Without proper planning, projects risk cost overruns, delays, and failure to deliver intended benefits, which undermines efforts to achieve sustainable agricultural development globally (PMI, 2020). On a global scale, many countries have embraced solar-powered irrigation to tackle water scarcity and energy challenges while promoting agricultural productivity. For instance, Israel and India have long been pioneers in deploying solar irrigation, supported by strong government policies and robust project planning frameworks that emphasize cost control, risk mitigation, and stakeholder coordination. These countries have demonstrated that projects with clear planning processes encompassing feasibility studies, budget monitoring, and quality control can deliver measurable improvements in crop yields and farmer incomes. The success of such projects aligns closely with the Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger) and SDG 7 (Affordable and Clean Energy). Globally, studies show that the integration of renewable energy with modern irrigation requires meticulous project planning to ensure technical, financial, and social sustainability, particularly in low-income rural communities. These global experiences highlight the critical role of project planning practices in enhancing the performance of solar-powered irrigation projects (Singh & Kumar, 2019). Within Africa, agriculture forms the backbone of most economies, employing over 60% of the continent's labor force and contributing between 20% and 30% to GDP in many countries. Despite its importance, many African agricultural projects face significant challenges linked to poor project planning and cost control, which often results in delayed implementation, inefficient resource use, and suboptimal outputs. According to the African Development Bank approximately 40% of agricultural projects in Sub-Saharan Africa exceed their budgets, while 30% experience significant delays, undermining their intended impact. Water scarcity and climate change intensify these challenges, prompting increased adoption of solar-powered irrigation as a sustainable alternative. However, the continent's experiences reveal a gap between project ambitions and actual performance, often due to weak budgeting, insufficient monitoring, and inadequate stakeholder engagement during project planning and execution phases. Therefore, the African context underscores the necessity

for improving project planning practices to enhance the effectiveness of irrigation and other agricultural interventions. (Munyua et al., 2018). Focusing on East Africa, the region has witnessed both successes and failures in irrigation and agricultural modernization projects. Countries such as Kenya, Tanzania, and Uganda have prioritized irrigation infrastructure to improve food security and reduce dependence on rain-fed agriculture. For example, Kenya's National Irrigation Authority has invested heavily in solar-powered and mechanized irrigation schemes aimed at boosting maize and horticultural production. However, project evaluations indicate that inadequate planning, including poor cost estimation, unrealistic scheduling, and weak stakeholder coordination, have limited the success of many initiatives. Tanzania presents a somewhat contrasting case where community involvement in project planning and implementation has contributed to better outcomes in some irrigation projects.These regional variations highlight the critical role that comprehensive project planning practices play in determining project performance and sustainability, especially in the integration of innovative technologies like solar-powered irrigation. (Mkumbwa et al., 2021).

Rwanda, with agriculture contributing approximately 35% of the country's GDP and engaging over 70% of its population, is heavily reliant on the sector for economic growth and poverty reduction. The government's strategic vision outlined in Vision 2050 and the Strategic Plan for Agricultural Transformation (PSTA) prioritizes modernizing agriculture through technology adoption and improved infrastructure. Large-scale projects, including irrigation schemes, have been launched to boost productivity and enhance food security. However, despite these investments, many agricultural projects face challenges such as budget overruns, delays, and incomplete deliverables, often resulting from poor project planning and weak cost management frameworks. Reports indicate that 76% of agricultural projects in Rwanda exceed their initial budgets, while 56% fail to deliver all intended outputs. This situation underscores a critical gap between the government's ambitious agricultural goals and the effectiveness of project planning practices used in project implementation. As Rwanda pursues agricultural modernization, there is a pressing need to examine how project planning practices influence project outcomes in order to strengthen project management frameworks and ensure successful delivery. (NISR, 2023). The Nasho Solar-Powered Irrigation Project, situated in the Kirehe District of Rwanda's Eastern Province, represents a flagship initiative aimed at transforming smallholder agriculture through renewable energy and modern irrigation technology. Funded by the Howard G. Buffett Foundation, with a budget of USD 54 million, the project encompasses 63 center pivot irrigation systems irrigating 1,173 hectares, a 3.3 MW solar power plant with 2.4 MW battery storage, and supportive infrastructure including 144 housing units and road networks. The project's objective is to improve on-farm productivity, reduce the energy burden on farmers, and promote sustainable land and water use practices. Since its inauguration in 2020, the Nasho project has facilitated increased crop yields, with maize production reaching between 5.5 and 10 metric tons per hectare, and beans and soybeans showing significant productivity gains (MINAGRI, 2023).

Despite the promising outcomes, the success of the Nasho project hinges largely on the effectiveness of its project planning practices, particularly in cost control, scheduling, and stakeholder coordination. Literature emphasizes that cost control is a pivotal component of project planning, ensuring that projects stay within budget while delivering on scope and quality. In agriculture, where unpredictable variables such as weather and input costs complicate project delivery, rigorous cost control from project inception through to completion is essential Moreover, continuous monitoring and adaptive planning are crucial to mitigating risks and ensuring timely completion. Given that many Rwandan agricultural projects have suffered from cost overruns and delays due to inadequate planning. investigating the planning practices employed in the Nasho project provides an important case for understanding how these factors influence project performance. (Buffett Foundation, 2020). This research, therefore, aims to critically examine the effect of project planning practices on the performance of the Nasho Solar-Powered Irrigation Project in Kirehe District.The study focused on key planning dimensions including cost control, scheduling, resource allocation, and stakeholder engagement, assessing how these have influenced project outcomes such as yield improvement, cost efficiency, and sustainability. By bridging gaps in existing literature and providing empirical evidence from a major Rwandan agricultural project, this research intends to contribute to strengthening project management frameworks that enhance the success rates of future agricultural and renewable energy initiatives in Rwanda and beyond.

2. Statement of the Problem

Agriculture remains a central pillar of Rwanda's economy, contributing significantly to food security, poverty reduction, and national development. To enhance productivity and resilience, the Government of Rwanda has invested in modern agricultural technologies, including solar-powered irrigation systems such as the Nasho Solar-Powered Irrigation Project. This initiative aims to promote year-round farming, improve rural livelihoods, and increase agricultural output. Despite these efforts, the performance of many agricultural projects in Rwanda remains below expectations, raising concerns about their long-term sustainability. Evidence indicates that a

significant number of agricultural projects experience serious implementation challenges. According to MINAGRI (2023), 76% of agricultural projects exceed their planned budgets, 56% fail to achieve intended outputs, 36% experience delays, and 66% do not meet expected quality standards. These performance gaps are largely attributed to weaknesses in project planning practices, particularly in cost management, time scheduling, resource allocation, and stakeholder engagement. As a result, many projects face cost overruns, delays, reduced effectiveness, and, in some cases, eventual failure. Cost control is a particularly critical issue. Agricultural projects are inherently exposed to uncertainties such as fluctuating input prices, climate variability, and supply chain disruptions. Without effective cost estimation, monitoring, and control mechanisms, projects are prone to inefficient resource utilization and financial mismanagement. In Rwanda, many agricultural initiatives rely on reactive financial reporting rather than proactive cost planning, which undermines their financial sustainability and overall performance. In addition, poor scheduling and unrealistic timelines further affect project outcomes. Agricultural activities are highly dependent on seasonal patterns and environmental conditions, yet many projects fail to align their implementation schedules with these realities. This often leads to delays, increased operational costs, and inefficient use of resources. Stakeholder engagement also remains a major challenge. Successful agricultural projects require the active involvement of multiple stakeholders, including government institutions, donors, technical experts, and farmers. However, inadequate stakeholder participation during the planning phase often results in low adoption of technologies, weak project ownership, and resistance during implementation. Although the Nasho project involves farmer cooperatives such as NAICO, there is limited empirical evidence on how stakeholder engagement influences its performance outcomes. Furthermore, there is a lack of empirical studies examining the relationship between project planning practices particularly cost control and project performance within Rwanda's agricultural sector. While theoretical literature emphasizes the importance of effective planning, little is known about how these practices impact real-world projects such as solar-powered irrigation schemes. Therefore, despite the potential of the Nasho Solar-Powered Irrigation Project to transform smallholder agriculture, its performance may be constrained by inadequate project planning practices. This study seeks to address this gap by examining the influence of project planning especially cost control, scheduling, and stakeholder engagement on project performance. The findings contributed to improving the effectiveness and sustainability of irrigation projects in Rwanda and similar contexts.

3. General Objectives

The general objective of this study is to examine the effect of project planning practices on the Success of Nasho Solar-Powered Irrigation Project in Kirehe District

4. Specific Objectives

i. To evaluate the effect of scope planning on milestone achievement in solar-powered irrigation projects.
ii. To examine the effect of resource planning on cost overruns in solar-powered irrigation projects.
iii. To assess the effect of risk management planning on the timely completion of project deliverables in solar-powered irrigation projects.

5. Literature Review

This chapter presents a critical review of existing literature related to the effect of project planning practices on the performance of solar-powered irrigation projects, with a specific focus on the Nasho Solar-Powered Irrigation Project in Kirehe District. The aim is to establish a solid theoretical and empirical foundation for understanding how planning elements such as scope planning, resource planning, and risk management planning influence key project performance indicators, including milestone achievement, cost control, and timely completion.

Theoretical Review

This section examines the theoretical perspectives that guide the understanding of project planning practices and their impact on the performance of solar-powered irrigation projects, with a focus on the Nasho project. It provides a theoretical framework to support the investigation of the three specific objectives of this study: evaluating the effect of scope planning on milestone achievement, examining the effect of resource planning on cost overruns, and assessing the effect of risk management planning on the timely completion of project deliverables.

Goal-Setting Theory

Goal-Setting Theory, developed by Locke and Latham (1990), posits that clear, specific, and challenging goals significantly improve performance by directing attention, mobilizing effort, and encouraging persistence. This theory is particularly relevant to scope planning, where defining clear project goals, deliverables, and milestones is critical for success. In the context of the Nasho Solar-Powered Irrigation Project, this theory helps explain how poorly defined project scopes may lead to ambiguity, confusion among stakeholders, and missed milestones. Conversely, well-articulated scope planning ensures that all parties understand their roles and expectations, thereby improving milestone achievement and project alignment. In summary, Goal-Setting Theory provides a foundation for analyzing

how clarity in scope planning contributes to the timely and successful attainment of project milestones.

Resource-Based View Theory

The Resource-Based View, advanced by Barney (1991), asserts that an organization's performance is dependent on its ability to effectively utilize valuable, rare, inimitable, and non-substitutable resources. This theory directly relates to resource planning, which involves forecasting and allocating human, financial, and material resources to optimize project outcomes. For the Nasho project, resource –Based View theory helps to examine how misallocation or underutilization of resources such as technical staff, irrigation infrastructure, and solar power systems could result in cost overruns. On the other hand, effective resource planning ensures that critical resources are available when needed, helping to control costs and maintain project efficiency. Thus, the Resource based View theory is essential in understanding the strategic importance of internal resources and how their management directly impacts cost performance in infrastructure projects.

Risk Management Theory

Risk Management Theory, as articulated by Hillson (2002), emphasizes identifying, analyzing, and responding to project risks to minimize their impact on project outcomes. It underpins the importance of risk management planning, particularly in sectors like agriculture and renewable energy, which are inherently exposed to uncertainties (e.g., climate variability, price fluctuations, and equipment failure). In the Nasho project, delays caused by unforeseen risks such as logistical challenges, procurement issues, or policy shifts can hinder timely delivery. Risk Management Theory supports the idea that proactive planning, including risk registers, contingency reserves, and mitigation strategies, is vital for on-time completion of project deliverables. In summary, this theory provides the basis for assessing how early identification and mitigation of risks through structured planning contribute to meeting project timelines and improving overall performance. In conclusion, these three theories Goal-Setting Theory, Resource-Based View Theory and Risk Management Theory form the theoretical foundation of this study. They collectively offer insights into how scope clarity, resource efficiency, risk anticipation, and balanced planning contribute to the performance of solar-powered irrigation projects like the Nasho project. By applying these theories, the study seeks to provide a nuanced understanding of how strategic project planning can mitigate common challenges such as cost overruns, delayed milestones, and incomplete deliverables.

Empirical Review

This section reviews empirical studies from global, African, East African, and Rwandan contexts that have examined the relationship between project planning practices and project performance in infrastructure development. The focus is on scope planning, resource planning, and risk management planning, particularly their impact on milestone achievement, cost overruns, and timely delivery in solar-powered or similar infrastructure projects.

Effect of Scope Planning on Milestone Achievement

Memon et al. (2018) conducted a study on infrastructure projects in Malaysia and found that inadequate scope definition accounted for over 60% of project delays. Unclear scope and frequent changes disrupted milestone achievement and led to client dissatisfaction. Similarly, Turner (2020) noted that projects in Europe and North America often struggle when scope is not adequately defined during initiation, causing milestone slippage and delays in subsequent phases. Odeh and Battaineh (2019), in their study on public sector projects in the Middle East and North Africa (MENA), found that improper scope planning often resulted in unrealistic goals, lack of alignment with stakeholders, and missed project milestones. Moreover, Ali and Nsengiyumva (2020) analyzed major public infrastructure projects in West Africa and concluded that over 70% of milestone delays were linked to vague or shifting project scopes. Khang and Moe (2018) focused on community-based irrigation projects in Kenya, Uganda, and Tanzania. They revealed that inadequate stakeholder involvement during scope planning led to misaligned expectations and scope creep, ultimately affecting the achievement of critical milestones. Mukamana and Habimana (2021) assessed agricultural infrastructure projects in Eastern Rwanda and observed that the absence of comprehensive scope planning, including early beneficiary engagement, caused confusion during execution and delayed milestone completion. In projects like Nasho Solar Irrigation, late-stage adjustments due to poor initial scope contributed to schedule overruns.

Effect of Resource Planning on Cost Overruns

Azis et al. (2019) examined 150 infrastructure projects across Southeast Asia and found that ineffective resource forecasting especially labor and equipment led to budget increases of 30–50%. Similarly, Chan and Kumaraswamy (2018) in their global review emphasized that well-structured resource planning was essential to avoid escalating costs due to idle time and over-purchasing. A study by Achieng and Ochieng (2020) in Nigeria and Ghana showed that 65% of construction projects exceeded their budgets due to poor resource allocation strategies, such as over-reliance on imported materials and fluctuating currency rates. Furthermore, resource mismanagement was a key contributor to both direct and indirect cost escalations in the energy and water sectors. Mugisha and Obonyo (2019) evaluated donor-funded solar irrigation projects in Uganda and Kenya. They found that delays in procuring solar panels, poor coordination with suppliers, and misalignment between local and donor procurement policies caused significant cost overruns especially in rural

installations where logistics were more complex. Uwizeyimana and Ndagijimana (2021) analyzed renewable energy projects in Rwanda and discovered that solar irrigation schemes suffered from budget overruns of up to 40% due to delayed procurement of specialized components and unavailability of local expertise. The authors concluded that early-stage resource planning, vendor engagement, and capacity-building are essential to minimize such cost risks.

Effect of Risk Management Planning on Timely Completion

Hillson and Simon (2020) found that international infrastructure projects that included formal risk identification, ranking, and mitigation plans were 45% more likely to meet their timelines. In particular, projects in unpredictable environments (e.g., politically unstable regions) benefited from dynamic risk planning frameworks and adaptive decision-making processes. In a study spanning several African countries, Ofori and Laryea (2019) observed that infrastructure projects with no formal risk registers or response strategies were chronically late. Risks such as political instability, poor weather forecasting, and unclear regulatory procedures frequently delayed deliverables. The study highlighted that most African governments underestimated risk management in the project lifecycle. Musyoka and Kimutai (2020) studied irrigation schemes in Kenya and Uganda and found that proactive risk management including regular risk assessments and contingency budgeting resulted in a 35% higher likelihood of on-time completion. Projects that lacked early risk assessment were highly susceptible to disruptions from seasonal weather patterns and transportation delays. Nyirinkindi (2022) examined solar irrigation systems in Rwanda's Eastern Province and noted that the absence of structured risk mitigation strategies especially concerning equipment delays, supplier risks, and community resistance led to timeline extensions of several months. Projects that had proactive stakeholder consultations and preemptive logistics planning fared significantly better in terms of timely delivery.

Effect of Planning Practices on Overall Project Success

Toor and Ogunlana (2019) reviewed integrated project planning strategies in Asia and Europe, concluding that projects with coordinated scope, resource, and risk planning frameworks achieved significantly better results in cost, time, and quality performance. They emphasized the role of integrated planning in managing complexity, especially in cross-border or donor-funded projects. Kwasi and Ncube (2021), in a comparative study across Sub-Saharan Africa, found that project success was highest when planning elements were not treated in isolation. Integrated planning reduced stakeholder conflict, enhanced communication, and improved project adaptability to unforeseen circumstances. The study noted that siloed planning led to misaligned efforts and resource wastage. Nabwire and Oduor (2020) studied infrastructure projects in East Africa and observed that only 22% of projects that lacked integrated planning were completed on time and within budget. In contrast, over 60% of projects that had comprehensive, coordinated plans showed strong performance in quality, cost, and delivery. In Rwanda, Niyitegeka and Uwitonze (2022) assessed large-scale rural infrastructure programs and found that integrated planning specifically involving local governments, engineers, and community representatives was a key success factor. Projects with unified planning teams that jointly addressed scope, resources, and risks demonstrated

Research Methods

The study adopted a quantitative approach and a descriptive research design supported by inferential analysis to examine the effect of project planning practices on the success of the Nasho Solar-Powered Irrigation Project in Kirehe District. The target population consisted of 240 individuals, including 200 farmers, 25 government officials, and 15 project staff. Using Yamane's formula at a 5% margin of error, a sample of 150 respondents was selected through proportionate stratified random sampling. Data were collected using structured questionnaires with Likert-scale questions, complemented by document analysis of relevant project records. A pilot study of 20 participants was conducted to assess the validity and reliability of the research instrument. Data were cleaned, coded, stored, and tabulated before analysis. SPSS was used to conduct descriptive and inferential analyses. Descriptive statistics included frequencies, percentages, means, and standard deviations, while correlation and multiple regression analyses were used to determine the relationships and effects of scope planning, resource planning, and risk management planning on project success. Project success was measured through milestone achievement, cost control, and timely completion. The study observed ethical principles through obtaining approval, informed consent, voluntary participation, confidentiality, anonymity, and secure data storage. The main limitations included the study's focus on a single project, the 2019–2024 timeframe, limited resources and stakeholder accessibility, and possible restricted access to confidential project documents.

Result and Discussion

This Section presents the discussions of the empirical findings of the study. It presents the descriptive statistics; the study examined the effect of project planning practices on the success of the Nasho Solar-Powered Irrigation Project in Kirehe District. Descriptive statistics was adopted to analyze means and standard deviation behavior, while inferential analysis was used to assess the effect of project planning practices on project success. Hence, (150) respondents were considered, and empirical results were arranged according to the study objectives.

Table 1: ***Processing Summary***

Gender	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Male	87	100.0%	0	0.0%	87	100.0%
Female	63	100.0%	0	0.0%	63	100.0%

Source: Field data 2026

According to table 1 of the case processing summary showed that the size of our data were 150 respondents where 87 were male and 63 respondents were females and there were no missing data.

Table 2: ***Tests of Normality***

	Gender	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	df	Sig.
Age	Male	.040	63	.200*	.991	63	.919
	Female	.078	87	.200*	.970	87	.290

Source: Field data 2026

According to the table 2 above shows that Kolmogorov–Smirnov statistic for male respondents were 0.040 with a significance value of 0.200, while the Shapiro–Wilk statistic were 0.991 and have a significance value of 0.919. while for female respondents, the Kolmogorov–Smirnov test statistic were 0.078 with a significance value of 0.200, and the Shapiro–Wilk test statistic was 0.970 with a significance value of 0.290. Since all significance values are greater than 0.05, this shows that the age for both male and female respondents were normally distributed.

Table 3: ***Respondent View on effect of scope planning on milestone achievement in solar-powered irrigation projects.***

Statement	**N**	**Mean**	**Std. Deviation**
Clear project objectives have helped guide timely completion of project milestones.	150	3.62	1.121
Lack of clarity in project objectives leads to missed or delayed milestones.	150	3.68	1.178
Scope planning enables clear communication of project goals to all stakeholders.	150	3.69	1.198
Proper documentation of project scope improves accountability and milestone achievement.	150	3.70	1.219
Changes in project scope are managed effectively to avoid unnecessary delays.	150	3.71	1.196
Well-defined deliverables improve coordination and reduce delays in the project timeline.	150	3.73	1.098
Detailed scope planning has minimized rework and contributed to on-time project progress.	150	3.77	1.177
The use of a Work Breakdown Structure (WBS) ensures better task allocation and milestone tracking.	150	3.78	1.140
Aggregate Averages	**150**	**3.71**	**1.165**

Source: Field data 2026

Table 3 above shows the mean scores of respondents' views focusing on the effect of scope planning on milestone achievement in solar-powered irrigation projects. As presented from the statements in Table 3, "the use of a Work Breakdown Structure (WBS) ensures better task allocation and milestone tracking" had a mean of 3.78 and was ranked first; "detailed scope planning has minimized rework and contributed to on-time project progress" had a mean of 3.77 and was ranked second; "well-defined deliverables improve coordination and reduce delays in the project timeline" had a mean of 3.73 and was ranked third; followed by "changes in project scope are managed effectively to avoid unnecessary delays" with a mean of 3.71; "proper documentation of project scope improves accountability and milestone achievement" with a mean of 3.70; "scope planning enables clear communication of project goals to all stakeholders" with a mean of 3.69; "lack of clarity in project objectives leads to missed or delayed milestones" with a mean of 3.68; and lastly "clear project objectives

have helped guide timely completion of project milestones" with a mean of 3.62. Overall, the mean scores ranged from (3.62–3.78). This indicates that all respondents agreed that scope planning significantly contributes to milestone achievement in solar-powered irrigation projects

Table 4: ***Respondent View on effect of resource planning on cost overruns in solar-powered irrigation projects***

Statements	N	Mean	Std. Deviation
Effective human resource allocation helps prevent labor shortages and reduces cost overruns.	150	3.68	1.166
Inadequate resource planning leads to increased project costs and budget overruns.	150	3.74	1.217
Resource planning includes contingency funds to manage unexpected expenses.	150	3.75	1.237
Coordination between procurement and project implementation teams reduces material wastage and delays.	150	3.77	1.234
Training and capacity building for project staff help optimize resource utilization and reduce costs.	150	3.78	1.268
Proper budgeting and cost estimation practices reduce the risk of cost overruns in the project.	150	3.79	1.139
Continuous monitoring of resource use improves cost control throughout the project lifecycle.	150	3.83	1.212
Procurement scheduling ensures timely availability of materials, reducing delays and costs.	150	3.85	1.184
Aggregate Average	**150**	**3.77**	**1.207**

Source: Field data 2026

Table 4 above shows the mean scores of respondents' views focusing on the effect of resource planning on cost overruns in solar-powered irrigation projects. As presented from the statements in Table 4, "procurement scheduling ensures timely availability of materials, reducing delays and costs" had a mean of 3.85 and was ranked first; "continuous monitoring of resource use improves cost control throughout the project lifecycle" had a mean of 3.83 and was ranked second; "proper budgeting and cost estimation practices reduce the risk of cost overruns in the project" had a mean of 3.79 and was ranked third; followed by "training and capacity building for project staff help optimize resource utilization and reduce costs" with a mean of 3.78; "coordination between procurement and project implementation teams reduces material wastage and delays" with a mean of 3.77; "resource planning includes contingency funds to manage unexpected expenses" with a mean of 3.75; "inadequate resource planning leads to increased project costs and budget overruns" with a mean of 3.74; and lastly "effective human resource allocation helps prevent labor shortages and reduces cost overruns" with a mean of 3.68. Overall, the mean scores ranged from (3.68–3.85). This indicates that all respondents agreed that effective resource planning significantly contributes to reducing cost overruns in solar-powered irrigation projects.

Table 5: ***Respondent View on effect of risk management planning on the timely completion of project deliverables in solar-powered irrigation projects***

Statements	N	Mean	Std. Deviation
Early identification of risks has helped in developing effective mitigation strategies.	150	3.73	1.060
Lack of effective risk management leads to delays in project deliverables.	150	3.78	1.140
Training on risk management enhances the project team's ability to handle unexpected challenges.	150	3.82	1.106
Risk mitigation plans have minimized disruptions, supporting timely delivery of project outputs.	150	3.83	1.039
Communication of risk status is clear and timely across all project levels.	150	3.85	1.073
Contingency plans are well established and effective in minimizing project delays.	150	3.87	1.082
Stakeholder involvement in risk management improves project adaptability and timely completion.	150	3.89	1.102
Regular monitoring of risks ensures quick response to issues that could delay the project.	150	3.90	1.085
Aggregate Average	**150**	**3.83**	**1.085**

Source: Field data 2026

According to Table 5, the findings indicated that respondents generally agreed that risk management planning positively influences the timely completion of project deliverables in solar-powered irrigation projects, as reflected by mean scores ranging from 3.73 to 3.90, with standard deviations ranging from 1.039 to 1.140, indicating moderate variation in respondents' opinions. The findings showed that regular monitoring of risks ensures quick

response to issues that could delay the project received the highest mean score (M = 3.90, SD = 1.085), suggesting that respondents strongly believed continuous risk monitoring enables timely identification and resolution of project challenges. This was followed by stakeholder involvement in risk management improves project adaptability and timely completion (M = 3.89, SD = 1.102) and contingency plans are well established and effective in minimizing project delays (M = 3.87, SD = 1.082), indicating that stakeholder participation and effective contingency planning play an important role in ensuring project schedules are maintained. Furthermore, respondents agreed that communication of risk status is clear and timely across all project levels (M = 3.85, SD = 1.073) and that risk mitigation plans have minimized disruptions, supporting timely delivery of project outputs (M = 3.83, SD = 1.039), implying that effective communication and mitigation strategies contribute to reducing interruptions during project implementation. Similarly, training on risk management enhances the project team's ability to handle unexpected challenges (M = 3.82, SD = 1.106) and lack of effective risk management leads to delays in project deliverables (M = 3.78, SD = 1.140) also received high levels of agreement, demonstrating the importance of capacity building and structured risk management practices in avoiding delays. Lastly, early identification of risks has helped in developing effective mitigation strategies recorded the lowest mean score (M = 3.73, SD = 1.060), although respondents still agreed with the statement, indicating that proactive risk identification remains an important component of successful project delivery. Overall, the findings suggest that respondents perceived risk management planning as a key factor in supporting the timely completion of project deliverables, particularly through regular risk monitoring, stakeholder involvement, contingency planning, effective communication, and implementation of appropriate mitigation measures.

Table 6: Respondent Perceptions on the Effect of Project Planning Practices on Project Success

	N	Mean	Std. Deviation
Effective project planning practices significantly contribute to the overall success of the Nasho Solar-Powered Irrigation Project.	150	3.63	1.250
Risk management planning helps in mitigating unforeseen challenges, supporting timely completion of project deliverables.	150	3.72	1.306
Poor project planning practices directly lead to delays, increased costs, and failure to meet project objectives.	150	3.75	1.301
Continuous monitoring and evaluation of project planning processes enhance project performance and success.	150	3.77	1.287
Clear scope planning improves the likelihood of achieving project milestones on time.	150	3.79	1.196
Stakeholder involvement during the project planning phase contributes positively to project success.	150	3.81	1.261
The success of the Nasho Solar-Powered Irrigation Project depends largely on how well project planning practices are implemented.	150	3.83	1.278
Adequate resource planning is essential for controlling costs and preventing budget overruns in the project.	150	3.85	1.239
Aggregate Average	**150**	**3.768**	**1.264**

Source: Field data 2026

Table 6 above shows the mean scores of respondents' perceptions on the effect of project planning practices on project success in the Nasho Solar-Powered Irrigation Project. As presented in Table 6, "adequate resource planning is essential for controlling costs and preventing budget overruns in the project" had a mean of 3.85 and was ranked first; "the success of the Nasho Solar-Powered Irrigation Project depends largely on how well project planning practices are implemented" had a mean of 3.83 and was ranked second; "stakeholder involvement during the project planning phase contributes positively to project success" had a mean of 3.81 and was ranked third; followed by "clear scope planning improves the likelihood of achieving project milestones on time" with a mean of 3.79; "continuous monitoring and evaluation of project planning processes enhance project performance and success" with a mean of 3.77; "poor project planning practices directly lead to delays, increased costs, and failure to meet project objectives" with a mean of 3.75; "risk management planning helps in mitigating unforeseen challenges, supporting timely completion of project deliverables" with a mean of 3.72; and lastly "effective project planning practices significantly contribute to the overall success of the Nasho Solar-Powered Irrigation Project" with a mean of 3.63. Overall, the mean scores ranged from (3.63–3.85). This indicates that respondents generally agreed that project planning practices have a significant effect on the success of the Nasho Solar-Powered Irrigation Project.

Table 7: *Model Summary*

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.989[a]	.978	.978	.172	1.120

Source: Field data 2026

According to Table7 above, the model summary indicated that the value of R Square of 0.978, which measures the goodness of fit, is very high and shows that the regression model was well fitted. The table also showed that the adjusted R Square of 0.978 indicated that the model, including scope planning, resource planning, and risk management planning, explains 97.8% of the variation in project success of the Nasho Solar-Powered Irrigation Project. This means that project planning practices significantly contribute to the overall success of the Nasho Solar-Powered Irrigation Project.

Table 8: *Coefficients regression results*

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-.050	.066		-.759	.449
	Scope planning	.567	.061	.532	9.339	.000
	Resource Planning	.099	.049	.111	2.002	.047
	Risk Management Planning	.346	.056	.355	6.143	.000

a. Dependent Variable: Project Success.

Source: Field data 2026

From Table 9 above of the coefficient regression results showed that scope planning is statistically significant even at the 0.01 level of significance. This is because the t-statistic for the coefficient of scope planning is 9.339, which is very high, and the probability of error is 0. 000.The coefficient of risk management planning is statistically significant at the 0.01 level of significance. Because the t-statistic for the coefficient of risk management planning is 6.143, which is high, and the probability of error is 0. 000.Lastly, the coefficient of resource planning is statistically significant at the 0.05 level of significance. This is because the t-statistic is 2.002, which is above the acceptable threshold, and the probability of error is 0.047. The table above confirmed that scope planning, resource planning, and risk management planning have statistically significant positive impact on project success in the Nasho Solar-Powered Irrigation Project.

Table 10: *ANOVA Result Test*

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	193.198	3	64.399	2188.957	.000[b]
	Residual	4.295	146	.029		
	Total	197.493	149			

a. Dependent Variable: Project Success.

Source: Field data 2026

To assess the statistical significance of the results of the R Square, it was necessary to look at the above ANOVA result test. From Table 10, it shows that the F-statistics of 2188.957 was very high, and the p-value **(**0.000**),** which is less than 0.05, indicates that the overall effect of the independent variables such as scope planning, resource planning, and risk management planning on project success as the dependent variable was statistically significant. The findings confirm that the regression model is significant in explaining project success in the Nasho Solar-Powered Irrigation Project.

Table 11: Hypotheses Test

Test Value = 0

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference Lower	Upper
ID	21.284	149	.000	75.500	68.49	82.51
Scope planning	47.863	149	.000	4.220	4.05	4.39
Resource Planning	41.913	149	.000	4.153	3.96	4.35
Risk Management Planning	42.716	149	.000	4.127	3.94	4.32
Project Success.	44.396	149	.000	4.173	3.99	4.36

Source: Field data 2026

To test the hypotheses, a one-sample t-test was conducted to determine whether the mean scores of the study variables were significantly different from the test value of zero. From Table 11, all the variables recorded statistically significant results, with p-values of 0.000**,** which are less than the significance level of 0.05. For Scope Planning, the results show a t-value of 47.863, with 149 degrees of freedom and a mean difference of 4.220. The p-value of 0.000 indicates that scope planning was statistically significant. Therefore, the hypothesis that scope planning has a significant effect on project success is supported**.**

For Resource Planning**,** the results show a t-value of 41.913, with 149 degrees of freedom, a mean difference of 4.153, and a p-value of 0.000**.** Since the p-value is less than 0.05, resource planning was statistically significant. Therefore, the hypothesis that resource planning has a significant effect on project success is supported**.** For Risk Management Planning, the results indicate a t-value of 42.716**,** with 149 degrees of freedom, a mean difference of 4.127, and a p-value of 0.000. This result demonstrates that risk management planning was statistically significant. Therefore, the hypothesis that risk management planning has a significant effect on project success is supported**.** Finally, Project Success recorded a t-value of 44.396, a mean difference of 4.173, and a p-value of 0.000, confirming that the measured level of project success was statistically significant. Overall, since the significance values for scope planning, resource planning, and risk management planning are all below 0.05, the study rejects the null hypotheses and accepts the alternative hypotheses. The findings therefore confirm that scope planning, resource planning, and risk management planning significantly contribute to project success in the Nasho Solar-Powered Irrigation Project.

Table 12: ***Correlations Analysis***

		Scope planning	Resource Planning	Risk Management Planning
Scope planning	Pearson Correlation	1	.968**	.971**
	Sig. (2-tailed)		.000	.000
	N	150	150	150
Resource Planning	Pearson Correlation	.968**	1	.969**
	Sig. (2-tailed)	.000		.000
	N	150	150	150
Risk Management Planning	Pearson Correlation	.971**	.969**	1
	Sig. (2-tailed)	.000	.000	
	N	150	150	150

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Field data 2026

The table 12 present correlations analysis and show the Pearson correlation between scope planning and resource planning is (0.968) with the significance level of 0.000, which indicated that is very high and shows a strong positive relationship between them. The correlation between scope planning and risk management planning is (0.971) with a significance level of 0.000, also this indicating a very strong positive relationship. Furthermore, the correlation between resource planning and risk management planning is (0.969) indicating a significance level of 0.000, that is also very high among all relationships. The findings showed that scope planning, resource planning, and risk management planning were strongly and positively related to each other, meaning that improvements in one planning practice are closely associated with improvements in the other planning practices in the Nasho Solar-Powered Irrigation Project.

Conclusion

The study concluded that project planning practices have a positive and statistically significant effect on the success of the Nasho Solar-Powered Irrigation Project in Kirehe District. The study was based on data collected from 150 respondents and examined three main planning practices: scope planning, resource planning, and risk management planning. Scope planning was found to significantly improve milestone achievement. Clear project objectives, proper use of the Work Breakdown Structure (WBS), well-defined deliverables, proper documentation, and effective

management of scope changes improved coordination and reduced delays. Resource planning significantly contributed to cost control. Proper budgeting, accurate cost estimation, procurement scheduling, continuous monitoring of resources, staff capacity building, and coordination between procurement and implementation teams helped reduce cost overruns and promote efficient resource utilization. Risk management planning also had a significant positive effect on the timely completion of project deliverables. Regular risk monitoring, early risk identification, stakeholder involvement, contingency planning, effective communication, and implementation of mitigation measures helped the project respond to potential problems and minimize delays. Overall, the study confirmed that effective scope planning, resource planning, and risk management planning jointly contribute to project success. The significant ANOVA result ($F = 2188.957$, $p < 0.001$) confirmed that the overall regression model was statistically significant. Therefore, the study rejected all three null hypotheses and concluded that strengthening project planning practices can improve project coordination, control costs, manage risks, achieve milestones, and ensure timely completion of large-scale solar-powered irrigation projects. The study recommended strengthening project scope definition, budgeting and procurement planning, risk identification and contingency planning, and stakeholder communication and coordination. Future researchers were encouraged to study other irrigation projects in Rwanda, stakeholder engagement, procurement management, and monitoring and evaluation systems to improve the generalization and understanding of project performance.

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