

Influence of resource planning practices on project success in the AIRTEA project in Musanze District, Rwanda

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ABSTRACT

This study assessed the influence of resource planning practices on the success of the Agricultural Knowledge and Innovation Ecosystem for Inclusive Rural Transformation and Livelihoods in Eastern Africa (AIRTEA) project in Musanze District, Rwanda. Specifically, the study examined the influence of human, financial, material, and technological resource planning on project success. The study was guided by Resource-Based Theory, Modern Portfolio Theory, Theory of Constraints, and Systems Theory. A descriptive and correlational research design was adopted. The study population comprised 1,384 individuals, including 20 staff from relevant institutions and 1,364 potato farmers engaged in the AIRTEA project. A sample of 310 respondents was selected, comprising all 20 staff and 290 farmers. Primary data were collected using structured questionnaires and semi-structured interviews, while secondary data were obtained from project reports and related records. Of the 310 sampled respondents, 302 provided complete responses, representing a response rate of 97.42%. Quantitative data were analyzed using descriptive statistics, Pearson correlation, and multiple linear regression in SPSS version 29, complemented by thematic analysis of qualitative data. The regression model was statistically significant, $F(4, 297) = 250.681$, $p < .001$, and explained 77.1% of the variance in project success ($R^2 = .771$; adjusted $R^2 = .768$). Human resource planning ($\beta = .296$, $p < .001$), financial resource planning ($\beta = .396$, $p < .001$), material resource planning ($\beta = .193$, $p < .001$), and technological resource planning ($\beta = .155$, $p < .001$) were all positive and statistically significant predictors of project success. The findings indicate that coordinated planning of human, financial, material, and technological resources is associated with successful implementation of agricultural development projects. The study recommends institutionalizing competency profiling, strengthening financial planning and control, improving material resource coordination, and enhancing technological infrastructure to support effective project implementation and sustainability.

Keywords: AIRTEA; Financial Resource Planning; Human Resource Planning; Material Resource Planning; Resource Planning Practices; Rwanda, Technological Resource Planning

I. INTRODUCTION

Resource planning defines how development initiatives translate intentions into lasting outcomes under conditions of environmental stress and economic transition. Canada illustrates this reality through climate responsive agricultural planning debates linked to long term irrigation dependent farming systems, where future oriented allocation of land, water, and skills determines production continuity. Planning grounded in historical stability weakens agricultural viability when climate variability alters growing conditions. Effective planning therefore treats resources as adaptive elements aligned with projected change rather than fixed inputs. This framing positions resource planning as a foundational requirement for performance within climate exposed agricultural systems (Lewis et al., 2023).

Italy demonstrates how resource planning has shifted in response to climate pressure affecting agricultural water systems and river basin management structures. Planning practices increasingly connect institutional coordination with physical infrastructure to maintain functionality under hydrological uncertainty. Where planning remains rigid, agricultural water systems struggle to respond to changing flow regimes and governance demands. Adaptive alignment of resources strengthens continuity without reliance on static allocation assumptions. This evolution confirms that planning quality shapes the capacity of agricultural systems to operate under environmental variability (Rossi & Peres, 2023).

Agricultural intensification under ecological constraint highlights the role of planning coherence, a pattern clearly visible in India within irrigated farming regions affected by drought propagation. Planning that separates water

availability from cropping and labor organization destabilizes production across climatic cycles. Integrated planning that aligns hydrological conditions with agricultural practices supports continuity under stress. Fragmented allocation accelerates resource strain and uneven outcomes. This context establishes planning integration as central to agricultural functionality under persistent ecological pressure (Das et al., 2022).

Shifts in labor and household organization redefine planning foundations, as shown in Bangladesh through rural agricultural settings affected by sustained male migration. Traditional planning assumptions no longer match responsibility patterns within farming systems. Agricultural initiatives that ignore changes in gendered access to land, water, and cash struggle to sustain productivity. Planning that recognizes social reorganization supports continuity of agricultural activity. This setting demonstrates that resource planning operates within social structures rather than technical arrangements alone (Leder, 2022).

Persistent water scarcity elevates planning discipline as a survival requirement, a condition evident in Morocco within irrigation dependent agricultural zones. Agricultural initiatives that disconnect financial allocation from hydrological availability experience instability. Planning that aligns water limits with agricultural input decisions maintains production consistency. Resource planning therefore mediates between food security goals and environmental constraint. This setting confirms that planning alignment determines agricultural continuity under arid conditions (Asif et al., 2023). Community governance of natural resources exposes planning tradeoffs clearly in Ghana through Community Resource Management Areas. Conservation coordination receives structured attention, while economic resource allocation remains limited. Where livelihood planning lacks clarity, community benefits diminish despite environmental protection. Strengthened planning around economic access and resource control sustains participation and continuity. This context shows that planning balance shapes both social and ecological outcomes (Mawutor & Hajjar, 2024).

Institutional coordination remains central to planning effectiveness, as illustrated in Uganda within integrated water management initiatives linked to national development objectives. Planning frameworks connect allocation principles with institutional arrangements, yet execution capacity constrains outcomes. Where planning ambition exceeds governance strength, service reliability declines. Effective planning therefore depends on alignment between allocation logic and institutional capability. This setting affirms planning realism as a determinant of operational continuity (Turyasingura et al., 2023). Infrastructure delivery demonstrates planning impact clearly, particularly in Kenya through county funded rural road projects in Nakuru County. Coordinated allocation of labor, materials, and finances stabilizes delivery timelines and quality standards. Weak planning produces delays and compromised outputs. Structured planning therefore translates directly into observable performance differences across projects. This experience reinforces planning discipline as central to public project delivery (Mokua & Nyaberi, 2024).

Agricultural transformation initiatives place planning at the center of national development outcomes, a reality evident in Rwanda through the Sustainable Agricultural Intensification and Food Security Project. Coordination of personnel, materials, and stakeholder engagement determines implementation consistency. Where planning frameworks guide allocation decisions, agricultural services maintain continuity and beneficiary satisfaction. Informal planning weakens scalability across intervention sites. This context positions planning as a core mechanism for agricultural project effectiveness (Gasana & Njenga, 2024).

Further national experience in Rwanda shows that alignment between human, financial, and physical resources shape agricultural delivery conditions within food security initiatives. Planning that reflects field realities stabilizes implementation timelines and cost management. Fragmented allocation undermines outcomes even under supportive policy environments. Resource planning therefore connects policy intent with operational reality. This reinforces planning as a structural requirement for national agricultural performance (Nyakarengo & Wanjiku, 2023). Private agricultural operations extend the national planning narrative in Rwanda, particularly through agriculture projects implemented at Holland Greentech. Planning that integrates scheduling, budgeting, and uncertainty anticipation strengthens coordination across implementation stages. Continuous planning maintains alignment between objectives and resource use. Static planning weakens adaptability under operational fluctuation. This experience confirms that planning discipline sustains performance across both public and private agricultural initiatives (Tuyisenge & Kabanda, 2023).

1.1 Statement of the Problem

Agricultural projects in Rwanda continue to experience uneven performance despite sustained policy support and the adoption of modern technologies. Weaknesses in resource management remain a key constraint affecting implementation and sustainability. For example, the Rice Meal Project in Rusizi District has faced limitations related to gaps in planning, coordination, monitoring, and capacity development, which have hindered effective synchronization of human, financial, material, and technological resources required for successful agricultural project outcomes (Uwiragiye & Dushimimana, 2025). Evidence from the Green Gicumbi Project indicates that financial resource management contributes to 73.3% of the variation in project success, yet climate variability continues to

threaten sustainability. In some cases, climate shocks are projected to reduce national GDP by between 5% and 7%, highlighting the persistent gap between financial planning and long-term agricultural project resilience (Mugabo, 2024).

In districts such as Nyamagabe, Karongi, and Nyabihu, farmers report yield losses of around 30%, while nearly 90% experience production challenges linked to pests, climate variability, limited input access, and soil-crop incompatibility. Environmental degradation further constrains project performance, as about 77% of Rwanda's land is vulnerable to soil erosion and nearly 90% of cropland lies on steep slopes, reducing land productivity and sustainability of agricultural interventions (Sunday et al., 2024). While existing studies including Uwiragiye and Dushimimana, (2025), Mugabo (2024), Mugabo (2024) have examined productivity and resource management in Rwanda, none has specifically examined the influence of resource planning on the success of Agricultural Knowledge and Innovation Ecosystem for Inclusive Rural Transformation and Livelihoods in Eastern Africa (AIRTEA) project in Musanze District, creating a critical gap in knowledge that this study seeks to address.

1.2 Research Objective

- i. To examine the influence of human resource planning on the success of the AIRTEA project in Musanze District.
- ii. To assess the influence of financial resource planning on the success of the AIRTEA project in Musanze District.
- iii. To evaluate the influence of material resource planning to the success of the AIRTEA project in Musanze District.
- iv. To determine the influence of technological resource planning on the success of the AIRTEA project in Musanze District.

II. LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 Resource Based Theory (RBT)

Resource Based Theory was formally articulated by Edith Penrose in 1959 through *The Theory of the Growth of the Firm*, which emphasized the productive use of internal resources as a basis for organizational growth (Langlois, 2024). The theory posits that sustainable competitive advantage and superior performance arise from valuable, rare, inimitable, and non-substitutable resources, including tangible and intangible assets such as knowledge, human capital, technological capabilities, and institutional networks (Iliyas & Barca, 2025; Salmi et al., 2024). Effective configuration and utilization of these resources enhance organizational capabilities, resilience, and performance, particularly under changing environmental conditions (Sugiarno & Novita, 2022; Sanders, 2023). In this study, RBT explains how effective human resource planning strengthens staff competencies, coordination, and project capabilities within the AIRTEA project in Musanze District, thereby contributing to project success.

2.1.2 Modern Portfolio Theory (MPT)

Modern Portfolio Theory, introduced by Harry Markowitz in 1952, explains how resources can be optimally allocated to maximize expected returns while managing risk through diversification and consideration of the relationships among different investments (Kousar et al., 2026). Optimal portfolio construction using modern portfolio theory and Sharpe's single index model: Evidence from NSE listed companies. *International Journal of Economics and Business Management Research*, 2(1), 48–53. <https://doi.org/10.64137/31079423/IJEBMR-V2I1P106>. The theory uses expected return, variance, and covariance to establish efficient allocation structures and emphasizes diversification as a mechanism for reducing risk while maintaining targeted returns (Hao, 2024; Chen, 2025). Contemporary applications incorporate computational optimization and risk-adjusted performance measures to improve resource allocation decisions under varying conditions (Kaya, 2024; Surtee & Alagidede, 2023). In this study, MPT explains how effective financial resource planning, allocation, prioritization, and risk management can enhance financial stability and efficiency in the AIRTEA project, thereby contributing to successful project implementation.

2.1.3 Theory of Constraints (TOC)

The Theory of Constraints, developed by Eliyahu Goldratt through *The Goal* in 1984, posits that the performance of any system is constrained by at least one limiting factor that restricts its overall output (Chikwanda & Mntambo, 2024). The theory advocates identifying the principal constraint, exploiting its capacity, aligning other processes with it, elevating the constraint, and continuously reassessing the system through the five focusing steps (Tarte et al., 2023). Its application in project and service environments demonstrates that identifying and addressing bottlenecks can improve workflow, resource utilization, service delivery, and efficiency (Datt et al., 2024; Moyo & Emuze, 2023). In this study, TOC explains how identifying and managing constraints in material resource planning can reduce delays, improve workflow, and optimize the utilization of project inputs, thereby enhancing the success of the AIRTEA project in Musanze District.

2.1.4 Systems Theory

Systems Theory views an organization or project as an interconnected system in which different components interact and collectively influence overall performance. The theory emphasizes that changes in one component can affect other components and the functioning of the system as a whole, making coordination and interaction among system elements essential for achieving desired outcomes (von Bertalanffy, 1968). In project environments, this perspective highlights the importance of coordinating resources, processes, people, technology, and organizational structures rather than managing them independently (Davis, 2025). In this study, Systems Theory explains how technological resource planning interacts with human, financial, and material resources to support coordinated project implementation. Effective integration of technological resources with other project components can improve information flow, coordination, monitoring, and decision-making, thereby contributing to the success of the AIRTEA project in Musanze District.

2.2 Empirical Review

2.2.1 Human Resource Planning and Project Success

López-Lemus *et al.* (2024) examined the influence of human resource effectiveness and efficiency on business project success in Mexico using a quantitative, explanatory, cross-sectional design involving 502 respondents. Structural equation modelling revealed significant positive relationships between effectiveness, efficiency, and project success, with effectiveness exerting a stronger influence ($\beta = 0.89$) than efficiency ($\beta = 0.35$). Jotabá *et al.* (2022) reviewed innovative human resource management practices using bibliometric and bibliographic techniques and identified organizational success, strategic HRM, employee behaviour, and learning management as major themes, although the study did not statistically examine their effects on measurable project outcomes. Kirmizi and Kocaoglu (2022), studying ERP projects in Turkey, found that project planning and management, employee commitment, and change management were significantly associated with project success, with the model explaining 65.179% of the variance. In Rwanda, Uwase *et al.* (2024) found a significant positive effect of human resource management on project success in the Building Learning Foundation project in Rulindo District ($\beta = 0.628$, $t = 9.721$, $p < 0.001$). However, the reviewed studies were largely conducted in contexts different from the AIRTEA agricultural project, creating a contextual gap that this study addresses by examining human resource planning and project success in Musanze District, Rwanda.

2.2.2 Financial Resource Planning and Project Success

Lu *et al.* (2024) found that co-financing significantly improved infrastructure project outcomes in developing countries, reducing project cancellation or suspension by 3.3–7.0 percentage points and improving environmental performance. Alsharari (2022) reported that structured planning and financial controls enhanced operational efficiency and process integration in ERP implementation, although the study did not statistically quantify the effect of financial planning on project performance. In Kenya, Kamau *et al.* (2023) established that financial project planning explained 35.4% of the variation in performance of floricultural projects in Nakuru County. Similarly, Cyubahiro and Dushimimana (2025) found a significant positive effect of budget planning on project performance in Rwanda ($\beta = 0.169$, $t = 3.075$, $p = 0.002$). Despite this evidence, most studies focused on specific sectors or individual projects, leaving a contextual gap concerning financial resource planning in agricultural development projects such as AIRTEA in Musanze District.

2.2.3 Material Resource Planning and Project Success

Adeosun (2023) established a significant association between material resource management and timely project completion in Nigeria, identifying material budgeting and reconciliation as important practices. Munkombwe and Chibomba (2025) similarly found that inadequate material planning, storage, and transportation contributed to poor-quality materials, delivery delays, increased costs, and reduced performance in road construction projects in Zambia. In Rwanda, Sauveur and Amolo (2025) reported a statistically significant positive effect of material resource management on water supply project performance ($p = 0.000$), while Mugorewase and Kwenza (2024) found a strong relationship between resource planning and project performance in a donor-funded education project in Gasabo District ($r = 0.654$, $p = 0.000$), with material planning contributing to overall performance. However, the reviewed studies largely focused on construction, water, and education projects, creating a sectoral gap regarding material resource planning in agricultural development projects such as AIRTEA.

2.2.4 Technological Resource Planning and Project Success

Pantović *et al.* (2024) found that data-driven strategies improved resource allocation, risk mitigation, and project success in IT project environments. Moleté *et al.* (2025), through a systematic review of 80 studies, reported

that alignment of IT strategies with organizational objectives was associated with improved operational outcomes, although resource constraints remained a major challenge. Nabeel (2024) further highlighted the role of artificial intelligence, predictive analytics, and real-time monitoring in improving resource forecasting, reducing delays, and controlling project costs, but did not provide statistical estimates of their effects on project success. In Rwanda, Sharamanzi (2024) identified broadband expansion, real-time data analytics, digital strategy alignment, and user-feedback systems as important technological factors associated with improved e-government service delivery. Nevertheless, existing studies provide limited empirical evidence on the influence of technological resource planning on individual development project success, particularly within agricultural projects in Rwanda, which this study addresses through the AIRTEA project in Musanze District.

III. METHODOLOGY

3.1 Research Design

The study employed a descriptive and correlational research design within a mixed-methods approach. The descriptive design was used to assess existing resource planning practices, while the correlational design examined the relationships between human, financial, material, and technological resource planning and project success. Quantitative data were collected using structured questionnaires, while qualitative data were obtained through semi-structured interviews to provide contextual insights into resource planning and project implementation.

3.2 Study Population

The study population comprised 1,384 individuals involved in the AIRTEA project in Musanze District, including 20 project staff and relevant institutional staff and 1,364 potato farmers participating in the project. The population provided the basis for selecting respondents capable of providing information on resource planning practices and project success.

3.3 Sample Size and Sampling Technique

The sample size was determined using Slovin's formula at a 5% margin of error, resulting in 310 respondents. Stratified sampling was used to distinguish the staff and farmer populations. A census approach was applied to the 20 staff members because of their small number, while 290 farmers were selected from the farmer population using simple random sampling. This approach ensured representation of the principal stakeholder groups involved in the AIRTEA project.

3.4 Data Collection Instruments

The study utilized primary and secondary data. Primary data were collected using structured questionnaires administered to selected respondents and semi-structured interviews conducted with relevant AIRTEA project stakeholders. The questionnaire measured human, financial, material, and technological resource planning and project success using closed-ended items on a five-point Likert scale. Secondary data were obtained through documentary review of AIRTEA project reports and related records. Additionally, semi-structured interviews were conducted with selected project stakeholders to obtain qualitative information concerning resource planning, implementation, monitoring, and project success. Interview responses were transcribed and analyzed thematically to complement the quantitative findings.

3.5 Data Analysis

Quantitative data were coded, cleaned, and analyzed using SPSS version 29. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize respondents' characteristics and resource planning practices. Pearson correlation analysis was used to determine the direction and strength of relationships between the independent variables and project success. Multiple linear regression was employed to determine the combined and individual effects of human, financial, material, and technological resource planning on project success at a 5% significance level. Qualitative interview data were transcribed, coded, and analyzed thematically to complement and contextualize the quantitative results.

The regression model was specified as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon$$

Where

Y represents project success; X_1 human resource planning; X_2 financial resource planning; X_3 material resource planning; X_4 technological resource planning; β_0 is the constant; β_1 – β_4 are regression coefficients; and ε is the error term.

3.6 Ethical Considerations

Ethical principles were observed throughout the study. Participants were informed about the purpose of the research, their voluntary participation, confidentiality, and right to withdraw. Informed consent was obtained before data collection, while questionnaires and interview records were coded to protect participants' identities. Data were securely stored and findings were reported in aggregate form. The study obtained authorization from the University of Kigali and AIRTEA project management, together with the necessary institutional clearance before data collection.

IV. FINDINGS & DISCUSSION

4.1 Response Rate

Of the 310 questionnaires distributed, 302 were completed and returned, representing a response rate of 97.42%. This provided an adequate basis for statistical analysis.

Table 1

Response Rate

Questionnaire	Frequency	Percentage
Complete and returned	302	97.42
Unreturned and incomplete	8	2.58
Total	310	100

4.2 Descriptive Statistics of Resource Planning Practices

4.2.1 Human Resource Planning

Human resource planning (HRP) was assessed using 12 items covering competency profiling, staffing forecasting, expertise allocation, and skills development. Respondents rated each statement on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The results are presented in Table 2.

Table 2

Descriptive Statistics on Human Resource Planning

Statement	N	Mean	Std. Dev.
Competency Profiling is clearly conducted to identify the required staff abilities for project implementation.	302	4.26	.51
Competency Profiling helps to match staff qualifications with assigned project activities.	302	4.17	.44
Competency Profiling supports the selection of personnel with relevant technical and managerial capacities.	302	4.22	.46
Staffing Forecasting is effectively carried out to determine the number of staff needed for project implementation.	302	4.32	.48
Staffing Forecasting helps to avoid shortages of staff during project implementation.	302	4.20	.49
Staffing Forecasting supports timely deployment of project staff across planned activities.	302	4.19	.48
Expertise Allocation is properly done to ensure that qualified staff are assigned to relevant project tasks.	302	4.16	.44
Expertise Allocation helps to use staff knowledge and experience effectively.	302	4.21	.42
Expertise Allocation improves coordination of technical responsibilities within the project.	302	4.30	.47
Skills Development opportunities are provided to improve staff capacity in project implementation.	302	4.21	.43
Skills Development helps project staff to adapt to technical and operational requirements.	302	4.19	.39
Skills Development strengthens the ability of project staff to deliver planned outputs effectively.	302	4.12	.33
Overall mean and standard deviation	302	4.21	.445

The findings indicate a generally high level of human resource planning, with an overall mean of 4.21 (SD = 0.445). Staffing forecasting recorded the highest mean score (M = 4.32, SD = 0.48), particularly in determining the number of staff required for implementation. Expertise allocation also received a high rating for improving coordination of technical responsibilities (M = 4.30, SD = 0.47), while competency profiling was highly rated for identifying required staff abilities (M = 4.26, SD = 0.51). Skills development recorded the lowest mean among the items (M = 4.12, SD = 0.33), although it remained within the high-rating range. The quantitative findings were supported by the qualitative interviews. The Project Manager explained:

"I ensure competency profiling is at the core of our operations to guarantee that every staff member possesses the exact technical abilities required for the AIRTEA project. I have seen that by carefully

matching these qualifications to specific project activities, we have significantly boosted the efficiency of our field interventions” (Project Manager).

Similarly, an administrative staff member noted:

“I personally benefit from the consistent staffing forecasting we conduct, which ensures that I am never overwhelmed by tasks due to a shortage of colleagues. I appreciate that my supervisors prioritize my professional growth through regular skills development opportunities.”

These findings suggest that systematic identification of competencies, forecasting of staffing requirements, allocation of expertise, and staff development were important features of resource planning within AIRTEA.

4.2.2 Financial Resource Planning

Financial resource planning (FRP) was assessed using 12 items covering budget structuring, fund phasing, resource allocation, and financial structuring. Respondents rated each statement on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The findings are presented in Table 3.

Table 3

Descriptive Statistics on Financial Resource Planning

Statement	N	Mean	Std. Dev.
Budget structuring clearly defines how financial resources are utilized during project implementation.	302	4.08	.33
Budget structuring aligns fund allocation with the requirements of planned project activities.	302	4.13	.35
Budget structuring ensures financial accountability throughout the project implementation period.	302	4.16	.37
Fund phasing schedules financial disbursements to coincide with project activity timelines.	302	4.24	.44
Fund phasing prevents operational delays caused by untimely financial disbursements.	302	4.24	.52
Fund phasing maintains a consistent flow of resources for the smooth implementation of project activities.	302	4.16	.45
Resource allocation prioritizes funds based on the specific financial needs of each project	302	4.24	.42
Resource allocation optimizes the use of available funds to achieve project results.	302	4.34	.48
Resource allocation maintains a balanced distribution of financial resources across all project components.	302	4.19	.48
Financial structuring organizes project funds in accordance with established project priorities.	302	4.18	.38
Financial structuring manages and controls expenditure levels during project implementation.	302	4.17	.39
Financial structuring promotes full transparency in the management of project finances.	302	4.10	.36
Overall mean and standard deviation	302	4.19	.414

The results indicate a high level of financial resource planning, with an overall mean of 4.19 (SD = 0.414). Resource allocation received the highest rating for optimizing available funds to achieve project results (M = 4.34, SD = 0.48). Fund phasing was also highly rated for scheduling disbursements in line with project activities (M = 4.24, SD = 0.44) and preventing operational delays associated with untimely funding (M = 4.24, SD = 0.52). The lowest-rated item concerned the definition of how financial resources were utilized through budget structuring (M = 4.08, SD = 0.33), although this still represented a high rating. The qualitative findings reinforced the quantitative results. The Project Manager stated:

“I manage the project budget with high precision, ensuring that every financial resource is structured to align perfectly with the specific needs of our planned agricultural activities. I have observed that this strict financial discipline promotes complete transparency, allowing me to provide clear accountability to all our stakeholders throughout the project cycle.”

An administrative staff member similarly observed:

“I have witnessed how our fund phasing schedules work to prevent the operational delays that used to stall our progress in the past. I am pleased that my department maintains a consistent flow of resources, which allows me to execute my tasks without worrying about sudden shortages in funding.”

The findings indicate that financial planning within AIRTEA involved aligning budgets with activities, phasing disbursements, prioritizing resource allocation, and maintaining expenditure controls.

4.2.3 Material Resource Planning

Material resource planning (MRP) was assessed using 12 items covering input procurement, storage design, asset identification, and distribution mapping. Respondents rated each statement on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The findings are presented in Table 4.

Table 4*Material Resource Planning*

Statement	N	Mean	Std. Dev.
Input procurement plans get materials ready on time for project activities.	302	4.18	.40
Input procurement helps to buy the quality materials needed for the project.	302	4.12	.43
Input procurement keeps planned project activities moving without stops.	302	4.22	.43
Storage design protects project materials from damage or loss.	302	4.26	.50
Storage design helps to keep materials safe and well-ordered.	302	4.17	.46
Storage design makes it easy to track and control project materials.	302	4.29	.46
Asset identification lists all materials and equipment used in the project.	302	4.26	.45
Asset identification helps to watch over the use of project assets.	302	4.07	.48
Asset identification makes it clear who is responsible for project resources.	302	4.15	.53
Distribution mapping guides the delivery of materials to project sites.	302	4.12	.36
Distribution mapping helps to cut down on delays in material delivery.	302	4.25	.44
Distribution mapping makes it easy to move materials across the project.	302	4.31	.48
Overall mean and standard deviation	302	4.20	.452

The findings demonstrate a high level of material resource planning, with an overall mean of 4.20 (SD = 0.452). Distribution mapping recorded the highest-rated item, with respondents indicating that it facilitated the movement of materials across the project (M = 4.31, SD = 0.48). This was followed by storage design for tracking and controlling project materials (M = 4.29, SD = 0.46), while storage design and asset identification each recorded a mean of 4.26 for protecting materials and identifying project resources, respectively. The lowest-rated item concerned the use of asset identification to monitor project assets (M = 4.07, SD = 0.48), although the rating remained high.

The quantitative findings were supported by the qualitative evidence. The Project Manager explained:

“I supervise a system where input procurement is planned well in advance, ensuring that all necessary materials are available on-site exactly when the farmers need them. I have designed our storage facilities to be highly secure, which has virtually eliminated the damage or loss of our valuable project equipment and inputs. By identifying every asset under my care, I am able to track our resources efficiently, ensuring that they are always used for the intended purpose of improving local livelihoods.”

The findings suggest that AIRTEA had established mechanisms for timely procurement, secure storage, asset accountability, and efficient distribution of materials.

4.2.4 Technological Resource Planning.

Technological resource planning (TRP) was assessed using 12 items covering system architecture, platform selection, data infrastructure, and connectivity setup. Respondents rated each statement on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The findings are presented in Table 5.

Table 5*Technological Resource Planning*

Statement	N	Mean	Std. Dev.
The system architecture matches the technological needs of the project well.	302	4.26	.504
The system architecture helps to organize digital systems for project work.	302	4.17	.455
The system architecture keeps the management of technological processes reliable.	302	4.29	.455
Careful platform selection picks the right digital tools for the project.	302	4.26	.449
Proper platform selection chooses technology that fits what project beneficiaries need.	302	4.07	.484
The platform selection helps staff to share data and talk easily.	302	4.15	.525
The data infrastructure stores information safely and makes it easy to find.	302	4.12	.357
The data infrastructure helps to keep project data accurate.	302	4.26	.504
The data infrastructure gives the facts needed to make good project decisions.	302	4.14	.416
The connectivity setup keeps digital project operations running without stopping.	302	4.25	.431
A strong connectivity setup helps staff and beneficiaries use digital services easily.	302	4.22	.420
The connectivity setup allows smooth communication within the project.	302	4.08	.427
Overall mean and standard deviation	302	4.19	.452

The findings indicate a high level of technological resource planning, with an overall mean of 4.19 (SD = 0.452). The highest-rated item concerned the reliability of technological processes supported by the system architecture (M = 4.29, SD = 0.455). This was followed by the alignment of system architecture with project technological needs (M = 4.26, SD = 0.504), platform selection (M = 4.26, SD = 0.449), and the contribution of data infrastructure to data accuracy (M = 4.26, SD = 0.504). The lowest-rated item concerned selecting technology that fits beneficiaries' needs (M = 4.07, SD = 0.484), although this remained within the high-rating category.

The qualitative findings reinforced the quantitative results. The Project Manager stated:

"I oversaw the design of a system architecture that perfectly matches the complex technological needs of our agricultural ecosystem. I have ensured that our data infrastructure stores information safely, which makes it incredibly easy for me to pull the facts needed to make sound, evidence-based decisions for the project. By selecting the right digital platforms, I have created an environment where my staff can share data and communicate with beneficiaries in real-time, greatly enhancing our coordination."

An administrative staff member similarly observed:

"I rely daily on our strong connectivity setup, which allows me to access digital services and communicate with my colleagues without any technical interruptions. I find that our data infrastructure keeps my project records accurate, which helps me focus on my core responsibilities rather than troubleshooting technical errors."

These findings suggest that technological resource planning within AIRTEA involved aligning technological infrastructure with project requirements, selecting appropriate digital platforms, maintaining reliable data systems, and ensuring connectivity for communication and service delivery.

4.2. 5 Success of the AIRTEA Project

Project success was assessed using 10 questionnaire items measuring five dimensions: relevance, effectiveness, efficiency, impact, and sustainability. Respondents rated each statement on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The findings are presented in Table 6.

Table 6

Success of the AIRTEA Project

Statement	N	Mean	Std. Dev.
The AIRTEA project demonstrated high relevance by aligning its interventions directly with the actual needs of beneficiaries.	302	4.13	.464
The relevance of the AIRTEA project is clearly evident in its active contribution to solving local project-related challenges.	302	4.11	.339
The AIRTEA project achieved a high level of effectiveness in meeting its planned objectives.	302	4.20	.400
The overall effectiveness of the AIRTEA project is clearly demonstrated by the successful delivery of all expected project outputs.	302	4.28	.467
The AIRTEA project maintained high efficiency through the proper and optimal use of available human, financial, material, and technological resources.	302	4.15	.422
The efficiency of the AIRTEA project is reflected in the timely completion of all planned project activities in Musanze District.	302	4.12	.328
The impact of the project is visible in the significant, positive changes experienced by beneficiaries in Musanze District.	302	4.11	.337
The AIRTEA project achieved a meaningful impact by substantially improving project outcomes among the target population.	302	4.14	.359
The sustainability of the AIRTEA project is clear, given the strong ability of project benefits to continue after official support ends.	302	4.25	.448
The sustainability of the AIRTEA project is safeguarded by the established local capacity to maintain project achievements in Musanze District.	302	4.18	.430
Overall mean and standard deviation	302	4.17	.399

The results indicate a high perceived level of AIRTEA project success, with an overall mean of 4.17 (SD = 0.399). Effectiveness in delivering expected project outputs received the highest rating (M = 4.28, SD = 0.467), followed by sustainability of project benefits (M = 4.25, SD = 0.448). The lowest-rated item concerned the contribution of the project to solving local challenges (M = 4.11, SD = 0.339), although it remained within the high-rating category. Overall, the findings indicate positive perceptions of the project's relevance, effectiveness, efficiency, impact, and sustainability. The survey findings were complemented by project-level records covering the period 2022–2025.

4.3 Correlation Analysis

Pearson product-moment correlation analysis was conducted to examine the relationships between human resource planning (HRP), financial resource planning (FRP), material resource planning (MRP), technological resource planning (TRP), and AIRTEA project success. The results are presented in Table 7.

Table 7

Pearson Correlation Matrix

		Human resource planning	Financial resource planning	Material resource planning	Technology resource planning	Project Success
Human resource planning	Pearson Correlation	1	.551**	.623**	.591**	.727**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	302	302	302	302	302
Financial resource planning	Pearson Correlation	.551**	1	.576**	.677**	.776**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	302	302	302	302	302
Material resource planning	Pearson Correlation	.623**	.576**	1	.651**	.707**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	302	302	302	302	302
Technology resource planning	Pearson Correlation	.591**	.677**	.651**	1	.724**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	302	302	302	302	302
Project Success	Pearson Correlation	.727**	.776**	.707**	.724**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	302	302	302	302	302

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

The results show that all four resource planning practices were positively and significantly associated with project success. Human resource planning had a significant positive correlation with project success ($r = .727$, $p < .01$), while financial resource planning recorded the strongest correlation ($r = .776$, $p < .01$). Material resource planning was also positively correlated with project success ($r = .707$, $p < .01$), as was technological resource planning ($r = .724$, $p < .01$). The explanatory variables were also positively correlated with one another, with coefficients ranging from $r = .551$ to $r = .677$ ($p < .01$). These relationships suggest that the resource planning practices were interconnected rather than operating independently. However, the correlations among the independent variables were not sufficiently high to indicate a serious multicollinearity concern, as confirmed by the variance inflation factor results presented in the regression analysis. The observed relationships indicate statistical association between the variables and provide a basis for the subsequent multiple linear regression analysis, which examines the unique contribution of each resource planning practice while controlling for the other planning dimensions.

4.5 Multiple Linear Regression Analysis

Multiple linear regression analysis was conducted to determine the extent to which human resource planning (HRP), financial resource planning (FRP), material resource planning (MRP), and technological resource planning (TRP) jointly and independently predicted AIRTEA project success. The analysis was based on 302 valid responses. The regression model was specified as:

$$\text{Project Success} = \beta_0 + \beta_1\text{HRP} + \beta_2\text{FRP} + \beta_3\text{MRP} + \beta_4\text{TRP} + \varepsilon$$

Where:

β_0 represents the constant, β_1 – β_4 represent the regression coefficients for the four resource planning practices, and ε represents the error term.

4.5.1 Model Summary

Table 8

Multiple Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.878 ^a	.771	.768	.180	1.760

a. Predictors: (Constant), Technology resource planning, Human resource planning, Financial resource planning, Material resource planning

b. Dependent Variable: Project Success

The model produced a multiple correlation coefficient of $R = .878$ and an R^2 of .771, indicating that the four resource planning practices jointly accounted for 77.1% of the variance in AIRTEA project success. The adjusted R^2 of .768 indicates that the model retained substantial explanatory power after adjustment for the number of predictors. The Durbin-Watson statistic of 1.760 provided no indication of substantial residual autocorrelation.

4.5.2 Analysis of Variance

The statistical significance of the overall regression model was assessed using analysis of variance (ANOVA), as presented in Table 9.

Table 9

ANOVA for the Regression Model

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	32.491	4	8.123	250.681	.000 ^b
	Residual	9.624	297	.032		
	Total	42.115	301			

a. Dependent Variable: Project Success

b. Predictors: (Constant), Technology resource planning, Human resource planning, Financial resource planning, Material resource planning

The ANOVA results show that the overall regression model was statistically significant, $F(4, 297) = 250.681$, $p < .001$. This indicates that the set of human, financial, material, and technological resource planning variables jointly provided statistically significant prediction of AIRTEA project success.

4.5.3 Regression Coefficients

The individual contributions of the four resource planning practices were examined using the regression coefficients presented in Table 10.

Table 10

Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.099	.135		.734	.464		
	Human resource planning	.274	.035	.296	7.812	.000	.534	1.872
	Financial resource planning	.404	.040	.396	10.032	.000	.494	2.024
	Material resource planning	.160	.033	.193	4.806	.000	.476	2.100
	Technology resource planning	.144	.039	.155	3.638	.000	.422	2.369

a. Dependent Variable: Project Success

The regression equation derived from the unstandardized coefficients was:

$$\text{Project Success} = 0.099 + 0.274\text{HRP} + 0.404\text{FRP} + 0.160\text{MRP} + 0.144\text{TRP} + \varepsilon$$

All four resource planning practices were statistically significant positive predictors of project success at the 5% significance level. Human resource planning: HRP had a positive and statistically significant relationship with project success ($B = .274$, $\beta = .296$, $t = 7.812$, $p < .001$). Holding the other resource planning practices constant, a one-unit increase in HRP was associated with a 0.274-unit increase in the project success score. The standardized coefficient indicates a positive contribution of HRP to project success.

Financial resource planning: FRP had a positive and statistically significant relationship with project success ($B = .404$, $\beta = .396$, $t = 10.032$, $p < .001$). Holding the other predictors constant, a one-unit increase in FRP was

associated with a 0.404-unit increase in the project success score. Among the four predictors, FRP had the largest standardized coefficient ($\beta = .396$). Material resource planning: MRP was also a statistically significant positive predictor of project success ($B = .160$, $\beta = .193$, $t = 4.806$, $p < .001$). A one-unit increase in MRP, holding the other predictors constant, was associated with a 0.160-unit increase in the project success score. Technological resource planning: TRP had a positive and statistically significant relationship with project success ($B = .144$, $\beta = .155$, $t = 3.638$, $p < .001$). Holding the other predictors constant, a one-unit increase in TRP was associated with a 0.144-unit increase in project success. The standardized coefficients indicate that the predictors differed in their relative statistical contribution to project success, with standardized β values of .396 for FRP, .296 for HRP, .193 for MRP, and .155 for TRP.

4.6 Hypothesis Testing

The four null hypotheses were tested using the multiple linear regression results at the 5% significance level. The decision rule was to reject the null hypothesis where the p-value was less than .05 and fail to reject it where the p-value was greater than .05. The results are presented in Table 11.

Table 11

Hypothesis Testing Results

Hypothesis	Standardized β	t-value	p-value	Decision
H01: Human resource planning has no statistically significant relationship with AIRTEA project success.	0.296	7.812	<.001	Reject H01
H02: Financial resource planning has no statistically significant relationship with AIRTEA project success.	0.396	10.032	<.001	Reject H02
H03: Material resource planning has no statistically significant relationship with AIRTEA project success.	0.193	4.806	<.001	Reject H03
H04: Technological resource planning has no statistically significant relationship with AIRTEA project success.	0.155	3.638	<.001	Reject H04

The results indicate that all four null hypotheses were rejected. Human resource planning was positively and significantly associated with project success ($\beta = .296$, $t = 7.812$, $p < .001$), providing evidence against H01. Financial resource planning also demonstrated a positive and statistically significant relationship with project success ($\beta = .396$, $t = 10.032$, $p < .001$), leading to the rejection of H02. Similarly, material resource planning was positively and significantly associated with project success ($\beta = .193$, $t = 4.806$, $p < .001$), resulting in the rejection of H03. Technological resource planning also had a positive and statistically significant relationship with project success ($\beta = .155$, $t = 3.638$, $p < .001$), leading to the rejection of H04.

Thus, the regression results provide evidence of statistically significant positive associations between each of the four resource planning practices and AIRTEA project success when the predictors are considered simultaneously. Among the predictors, financial resource planning had the largest standardized coefficient ($\beta = .396$), followed by human resource planning ($\beta = .296$), material resource planning ($\beta = .193$), and technological resource planning ($\beta = .155$). These coefficients indicate relative statistical contributions within the fitted model and should not be interpreted as causal effects.

4.2 Discussion

4.2.1 Human Resource Planning and Project Success

The study found a positive and statistically significant association between human resource planning and AIRTEA project success ($\beta = .296$, $t = 7.812$, $p < .001$). The descriptive findings showed high ratings for competency profiling, staffing forecasting, expertise allocation, and skills development, with an overall mean of 4.21. These results suggest that identifying required competencies, matching staff qualifications with project activities, forecasting staffing requirements, and developing staff capacities were important features of project implementation.

The finding is consistent with Jotabá et al. (2022), who emphasize the importance of strategic human resource practices in supporting organizational and project effectiveness. It also agrees with López-Lemus et al. (2024), who found positive relationships between human resource practices and organizational effectiveness and efficiency. Similarly, Uwase et al. (2024) reported a significant positive relationship between resource-related management practices and project performance in Rwanda. The consistency across these studies suggests that appropriate planning and deployment of human capabilities can support coordination and delivery of project activities.

The finding is further explained by Resource-Based Theory, which views human knowledge, skills, experience, and organizational capabilities as strategic resources. Within AIRTEA, competency profiling and expertise allocation provide mechanisms for aligning these resources with project requirements, while skills development can

strengthen the capacity of personnel to respond to changing implementation demands. The significant regression coefficient therefore indicates that variation in human resource planning was associated with variation in project success after accounting for the other resource planning dimensions.

4.2.2 Financial Resource Planning and Project Success

Financial resource planning demonstrated a positive and statistically significant association with AIRTEA project success ($\beta = .396$, $t = 10.032$, $p < .001$). It also had the largest standardized coefficient among the four predictors. The descriptive results showed high ratings for budget structuring, fund phasing, resource allocation, and financial structuring, with an overall mean of 4.19. This indicates that respondents perceived alignment of financial resources with project activities, timely disbursement, expenditure control, and financial accountability as important aspects of implementation.

The finding is consistent with Kamau et al. (2023), who reported a significant relationship between financial project planning and project performance in floricultural projects in Nakuru County. It also corresponds with Cyubahiro and Dushimimana (2025), who found a significant positive effect of budget planning on the performance of a social protection project in Rwanda. Alsharari (2022) similarly emphasizes the contribution of structured financial and organizational processes to operational efficiency. The present study extends these findings to an agricultural development project by demonstrating a significant association between financial resource planning and project success in the AIRTEA context.

The finding is consistent with Modern Portfolio Theory, which emphasizes systematic allocation of available resources in pursuit of defined objectives while taking account of competing demands and risk. In AIRTEA, budget structuring and resource allocation provide mechanisms for directing limited financial resources towards planned activities, while fund phasing can support continuity of implementation. The relatively larger standardized coefficient for financial resource planning indicates that it made the largest relative statistical contribution to project success within the fitted model.

4.2.3 Material Resource Planning and Project Success

Material resource planning was positively and significantly associated with AIRTEA project success ($\beta = .193$, $t = 4.806$, $p < .001$). The overall descriptive mean of 4.20 indicates high ratings for input procurement, storage design, asset identification, and distribution mapping. Respondents particularly rated distribution mapping, storage control, and asset identification highly. These findings suggest that timely procurement, appropriate storage, asset accountability, and effective distribution were important components of project implementation.

The finding is consistent with Adeosun (2023), who identified a significant relationship between material resource management and timely project completion. It also agrees with Sauveur and Amolo (2025), who reported a significant positive relationship between material resource management and performance of a water project in Rwanda. Munkombwe and Chibomba (2025) similarly demonstrate how inadequate material planning, storage, and transportation can contribute to delays and additional project costs. The present finding therefore reinforces evidence that material resource planning is relevant to successful project implementation, while extending this evidence to agricultural development interventions.

The result is also consistent with the Theory of Constraints, which proposes that system performance can be affected by constraints that limit the flow of activities. In an agricultural project, shortages, poor storage, or delayed distribution of inputs and equipment can interrupt implementation activities. Planning procurement and distribution can therefore help reduce such operational constraints. The significant coefficient observed in this study indicates that material resource planning contributed positively to explaining variation in AIRTEA project success after accounting for the other resource planning practices.

4.2.4 Technological Resource Planning and Project Success

Technological resource planning also demonstrated a positive and statistically significant association with AIRTEA project success ($\beta = .155$, $t = 3.638$, $p < .001$). The descriptive findings showed a high overall mean of 4.19 across system architecture, platform selection, data infrastructure, and connectivity. Respondents particularly recognized the role of system architecture in maintaining reliable technological processes and the contribution of data infrastructure to accurate project information.

The finding is consistent with Pantović et al. (2024), who emphasize the contribution of data-driven approaches to resource allocation, coordination, and project performance. It also corresponds with Alsharari (2022), who highlights the importance of integrated technological systems in improving organizational processes. Moleté et al. (2025) similarly identify technological alignment and appropriate information systems as important considerations in improving project outcomes. The finding further supports the view that technological resources can strengthen information availability, coordination, monitoring, and decision-making within development projects.

The finding is explained by Systems Theory, which views an organization or project as an interconnected system whose components interact to achieve common objectives. Within AIRTEA, technological infrastructure interacts with human, financial, and material resources by facilitating communication, information management, monitoring, and decision-making. Effective technological planning can therefore strengthen the linkages among other project resources. Although technological resource planning had the smallest standardized coefficient among the four predictors, its statistically significant positive association indicates that it made a distinct contribution to explaining project success.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

The study concludes that resource planning practices were positively and significantly associated with the success of the AIRTEA project in Musanze District, Rwanda. The multiple regression model was statistically significant ($F(4, 297) = 250.681, p < .001$) and explained 77.1% of the variance in project success. Human resource planning was positively associated with project success ($\beta = .296, p < .001$), indicating the importance of competency profiling, staffing forecasting, expertise allocation, and skills development. Financial resource planning had the largest standardized coefficient ($\beta = .396, p < .001$), highlighting the importance of effective budgeting, fund phasing, resource allocation, and financial control. Material resource planning was also positively associated with project success ($\beta = .193, p < .001$), particularly through procurement, storage, asset identification, and distribution. Technological resource planning demonstrated a significant positive association ($\beta = .155, p < .001$), underscoring the contribution of appropriate digital infrastructure, platforms, data systems, and connectivity. Overall, the findings indicate that integrated planning and coordination of human, financial, material, and technological resources are important for successful implementation of agricultural development projects such as AIRTEA.

5.2 Recommendations

The study recommends that AIRTEA management institutionalize competency profiling and staffing forecasting to ensure that personnel qualifications and staffing levels correspond to project requirements. Continuous skills development should also be integrated into project implementation. Financial management should be strengthened through activity-based budgeting, timely fund phasing, expenditure monitoring, and transparent resource allocation to minimize funding-related implementation disruptions. Project managers should maintain timely procurement, secure storage, systematic asset identification, and effective distribution mapping to ensure that materials and inputs are available when and where required. Finally, AIRTEA and similar agricultural development projects should strengthen technological planning, particularly through appropriate digital platforms, reliable data infrastructure, and connectivity, to improve communication, monitoring, information management, and decision-making.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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