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## **OPTIMIZING RESOURCE MANAGEMENT AND EFFICIENCY IN PUBLIC-PRIVATE PARTNERSHIPS FOR INFRASTRUCTURE DEVELOPMENT IN RWANDA**

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### **ABSTRACT**

**Background and problem statement:** This study investigates resource management practices within Public-Private Partnerships (PPPs) in Rwanda's construction and infrastructure sector to identify operational inefficiencies and propose optimization strategies. Despite strong policy frameworks under Vision 2050 and the National Strategy for Transformation (NST1 and NST2), PPP projects in Rwanda continue to experience cost overruns, project delays, and underutilized resources, primarily linked to weak resource planning, fragmented coordination, limited skilled labor, and inadequate risk management capacity.

**Methodology:** A mixed-methods approach was adopted, combining quantitative and qualitative methods. Data were collected through a structured survey of 54 professionals, 15 semi-structured interviews, 3 focus group discussions, document analysis, and site visits to selected major PPP projects in Rwanda.

**Results and Findings:** Findings reveal that only 20% of respondents perceive current resource allocation as efficient, while approximately 80% report project delays linked to mismanagement. Funding inconsistencies (67%), lack of transparency (72%), and communication gaps (74%) were identified as the most critical challenges significantly affecting PPP efficiency.

**Conclusion and Recommendations:** Balanced risk allocation, digital monitoring systems, lifecycle planning, performance-based contracting, and institutional capacity strengthening are recommended to enhance PPP resource management and accelerate sustainable infrastructure development in Rwanda.

**Keywords:** *Public-Private Partnerships, resource management, infrastructure development, Rwanda, project efficiency.*

## **1. INTRODUCTION**

Rwanda has achieved sustained economic growth driven by strategic infrastructure investments under Vision 2050 and the National Strategy for Transformation (NST1 and NST2). To address infrastructure financing gaps and strengthen technical capacity, the Government of Rwanda has increasingly adopted Public-Private Partnerships (PPPs) across transport, energy, water, irrigation, and housing sectors. Despite their importance, many PPP projects continue to experience inefficiencies in resource allocation, delays, cost overruns, limited skilled labor, and weaknesses in risk management, particularly within the construction sector.

In Sub-Saharan Africa, PPPs are widely used to mobilize private capital and improve infrastructure delivery; however, implementation challenges remain significant. Existing literature emphasizes the benefits of PPPs in reducing public debt and enhancing project efficiency, yet most studies are theoretical or focused on other countries, with limited empirical evidence from Rwanda's construction context. Practical strategies for optimizing resource management in Rwandan PPP projects remain insufficiently explored.

This study investigates resource management practices in PPP construction projects in Rwanda, identifies key challenges, and proposes strategies to enhance efficiency, cost control, and overall project performance. The findings provide evidence-based recommendations for policymakers, private sector actors, and development partners to strengthen PPP implementation and infrastructure sustainability.

## **2. STATEMENT OF THE PROBLEM**

Public-Private Partnerships (PPPs) are increasingly adopted in Sub-Saharan Africa, including Rwanda, as a strategic mechanism to address infrastructure financing gaps and improve service delivery. Despite their potential to enhance efficiency through collaboration between public oversight and private sector innovation, many PPP projects continue to experience persistent resource management challenges. In Rwanda's construction sector, these challenges include cost overruns, project delays, inefficient resource allocation, weak stakeholder coordination, limited skilled labor, inadequate risk management capacity, and institutional constraints.

Existing studies across Sub-Saharan Africa highlight similar concerns; however, most research focuses on financial structuring, governance frameworks, or broader policy issues rather than operational resource management at the project level. Furthermore, empirical evidence specific

to Rwanda's PPP construction projects remains limited. Gaps persist in understanding how human, financial, and material resources are planned, allocated, and controlled within ongoing PPP projects. The lack of context-specific empirical analysis restricts the development of practical, evidence-based solutions tailored to Rwanda's infrastructure environment.

Therefore, this study investigates resource management practices in Rwanda's PPP construction projects using a mixed-methods approach to generate empirical evidence, strengthen statistical analysis, synthesize case experiences, and inform actionable policy and operational recommendations for improved project performance and sustainability.

### **3. RESEARCH OBJECTIVES**

This study aimed to examine and optimize resource management practices in Public-Private Partnership (PPP) infrastructure projects within Rwanda's construction sector. The primary objective was to analyze the relationship between human, financial, and material resource management and project efficiency, with the intention of developing an evidence-based framework for improved performance. The specific objectives were to:

1. Assess financial resource allocation efficiency in PPPs.
2. Evaluate human resource and skills constraints.
3. Analyze stakeholder coordination mechanisms.
4. Develop an integrated resource management framework.

### **4. RESEARCH HYPOTHESES/QUESTIONS**

This study is guided by hypotheses examining the relationship between resource management practices and project efficiency in Rwanda's PPP construction sector. It tests whether effective management of human, financial, and material resources significantly improves project performance in terms of cost control, time delivery, and quality outcomes. Additional hypotheses assess the influence of stakeholder coordination, skilled labor availability, and risk management capacity on overall PPP efficiency. The study also addresses research questions on existing resource management practices, operational challenges, and barriers to optimization, providing empirical evidence to inform policy, institutional reforms, and evidence-based PPP frameworks.

**RQ1:** How does resource allocation affect PPP efficiency?

**RQ2:** What coordination challenges hinder optimization?

**RQ3:** How do labor shortages affect project timelines?

## **5. THEORETICAL REVIEW/Framework**

This study is grounded in multiple complementary theories explaining Public-Private Partnership (PPP) performance. Economic theories, including principal–agent and transaction-cost perspectives, emphasize efficient risk allocation and cost minimization. Governance and network theories highlight stakeholder coordination, institutional alignment, and collaborative decision-making. Institutional theory underscores the role of regulatory frameworks, PPP units, and formal rules in shaping project outcomes. The resource-based view further suggests that integrating public assets (e.g., land, policy authority) with private sector capital and technical expertise enhances infrastructure delivery performance.

This study integrates Principal-Agent Theory (Eisenhardt, 1989), Transaction Cost Economics (Williamson, 1981), Resource-Based View (Barney, 1991), and Institutional Theory to explain inefficiencies and governance gaps in PPPs. These theoretical lenses collectively provide a robust foundation for analyzing how resource management decisions affect project performance in Rwanda's PPP construction sector.

## **6. EMPIRICAL REVIEW**

Empirical literature on PPP resource management largely relies on qualitative case studies and conceptual models, with limited application of mixed-methods designs (Li et al., 2021; Osei-Tutu & Boateng, 2021). Few studies integrate stakeholder surveys, project performance data, and field-based analysis, particularly within Rwanda's construction sector (Murekezi et al., 2024). This methodological limitation restricts the development of context-specific and evidence-based resource management frameworks. Existing research is also sectoral fragmented, focusing independently on transport, energy, or water projects, with minimal cross-sectoral comparison to inform broader resource optimization strategies (Deloitte, 2019; OECD, 2019).

Most empirical findings emphasize financial management and risk allocation, while insufficient attention is given to human resource capacity, material supply chains, digital monitoring tools, and sustainability integration (Liu & Yang, 2022; Nguyen et al., 2019).

Furthermore, localized evidence addressing institutional capacity, stakeholder coordination, and operational efficiency remains scarce (Akomea-Frimpong et al., 2023; Kocemska, 2019).

Empirical studies in Ghana, Nigeria, Zambia, Kenya, and South Africa show that PPP success depends on balanced risk allocation, strong governance, and lifecycle planning (Osei-Kyei & Chan, 2016; Kaliba et al., 2018). Failures often stem from weak institutional capacity and unrealistic financial assumptions (Ogunlana et al., 2021). To address these gaps, this study adopts a mixed-methods approach to generate empirical evidence from multiple PPP projects in Rwanda, aiming to develop a context-specific resource management framework and provide actionable policy and managerial recommendations (Murekezi et al., 2024).

Digital tools and information and communication technology (ICT) have emerged as critical enablers of resource efficiency in PPP projects. Evidence from Tanzania and China demonstrates that ICT-integrated procurement planning and digital monitoring platforms improve real-time resource tracking, reduce waste, and enhance transparency (Kavishe & Chileshe, 2020; Liu et al., 2020). However, their adoption in Rwanda and comparable Sub-Saharan African contexts remains nascent, underscoring the need for context-specific digital transformation strategies (Nduhura et al., 2021). The COVID-19 pandemic further exposed the vulnerability of PPP service continuity to resource disruptions, highlighting the importance of resilient resource management systems (Nduhura et al., 2021).

Human resource management represents a persistently underexamined dimension in PPP empirical literature. Zawawi and Kamaruzzaman (2020) found that skills gaps in contract administration, project monitoring, and technical oversight significantly undermine resource optimization in developing country PPPs. Similarly, Chileshe et al. (2023) emphasize that capacity development interventions including structured training, knowledge transfer programs, and professional certification are critical to improving PPP performance in Sub-Saharan Africa. Akinmoladun and Oke (2020) further document how inadequate stakeholder management compounds human resource deficiencies, resulting in fragmented coordination and project delays. These findings collectively underscore the need for integrated approaches that address both technical and managerial dimensions of resource management in Rwanda's PPP construction sector.

## 7. CONCEPTUAL FRAMEWORK

This study develops a conceptual framework linking resource management practices to efficiency and collaboration in Rwanda's PPP construction projects. The framework posits that effective allocation and integration of human, financial, and material resources directly enhances project performance in terms of cost control, timely delivery, and quality outcomes. Stakeholder collaboration among government agencies, private contractors, and community representatives is identified as a central mediating factor influencing resource utilization efficiency.

The model further integrates communication quality, transparency, and institutional capacity as key determinants of successful resource coordination (Godt, 2023; Dykes & Jones, 2016). Empirical survey findings indicate that inadequate funding consistency, weak transparency, and poor communication significantly reduce efficiency, while stakeholder misalignment increases delays and cost overruns (Akomea-Frimpong et al., 2023). These variables collectively affect overall project sustainability and value realization (Liu & Yang, 2022).

The framework also incorporates capacity-building initiatives, standardized resource management protocols, and digital communication platforms as strategic interventions to improve coordination and accountability (Kavishe & Chileshe, 2020; Liu et al., 2020). By embedding empirical evidence within theoretical foundations of governance, institutional, and resource-based perspectives, the framework provides a structured model for optimizing PPP resource management (Chileshe et al., 2023). This integrated approach supports evidence-based policymaking and operational reforms aimed at strengthening infrastructure delivery in Rwanda and comparable Sub-Saharan African contexts (Godt, 2022; OECD, 2019).

**PPP Efficiency Model:** [Financial Resources] + [Human Capital] + [Material Supply Chain] + [Risk Allocation] + [Digital Monitoring] → Project Efficiency Outcomes

## 8. RESEARCH METHODOLOGY

This study adopted a mixed-methods research design to examine resource management practices in Rwanda's Public–Private Partnership (PPP) construction projects. The approach combined quantitative and qualitative methods to ensure comprehensive analysis and triangulation of findings. A purposive sampling strategy was used to select key stakeholders,

including government officials, PPP unit staff, construction managers, financial experts, and regulatory representatives with at least two years of PPP experience.

The study involved 15 semi-structured interviews, 3 focus groups, and a structured survey of 54 professionals. Additionally, document analysis of PPP contracts, institutional reports, and project records was conducted, complemented by site visits to selected projects. Data were collected through structured questionnaires (n=85), interviews with 15 key stakeholders, and analysis of four major PPP case studies.

Qualitative data were analyzed using thematic coding, while quantitative data were processed using descriptive and inferential statistics, including reliability testing (Cronbach's alpha). Ethical standards were observed through informed consent, confidentiality, and institutional approval. This methodological framework ensured robust empirical evidence to support policy and operational recommendations.

## **9. RESULTS AND DISCUSSIONS**

The findings reveal significant inefficiencies in resource management within Rwanda's PPP construction projects. Survey results indicate that only 20% of respondents perceive current resource allocation as efficient, while approximately 80% report project delays linked to mismanagement. Financial constraints emerged as the most critical challenge, followed by human resource gaps and moderate stakeholder coordination. Over 70% of respondents cited inadequate transparency and communication as key barriers affecting efficiency.

Interview data highlighted fragmented responsibilities, regulatory bottlenecks, limited technical capacity, and weak risk management practices (Ogunlana et al., 2021; Leigland, 2020). Participants emphasized the need for institutional strengthening, standardized protocols, and digital project management tools (Liu et al., 2020; Kavishe & Chileshe, 2020). Focus group discussions reinforced these findings, identifying coordination challenges, trust deficits, and conflicting stakeholder priorities, while recommending integrated planning frameworks, performance-based contracts, and centralized coordination units (El-Gohary et al., 2016; Akinmoladun & Oke, 2020).

Case studies of major PPP projects-including energy, water, transport, agriculture, and innovation initiatives-demonstrate the effectiveness of blended financing, phased implementation, and structured institutional oversight (Rwanda Development Board, 2021;

Rwanda Energy Group, 2021; SMEC, 2021). However, recurring issues such as feasibility gaps and approval delays persist (Godt, 2022; Nguyen et al., 2019). Overall, results confirm that enhanced stakeholder collaboration, capacity building, streamlined governance, and digital monitoring systems are essential to optimize resource management and improve PPP project efficiency in Rwanda (World Bank, 2020; Chileshe et al., 2023).

Financial resource management emerged as the most acute challenge across all data sources. Survey findings reveal that 67% of respondents reported inconsistent funding flows as a primary cause of project delays, while 72% cited lack of transparency in financial reporting as a contributor to resource underutilization. These findings align with evidence from Zambia, Nigeria, and Ghana, where similar patterns of financial mismanagement and audit deficiencies have been documented (Kaliba et al., 2018; Osei-Tutu & Boateng, 2021). In Rwanda, blended financing models piloted under the Lake Kivu methane gas extraction and Gabiro agribusiness hub projects demonstrated that structured public-private co-financing arrangements can mitigate funding inconsistencies and improve budget adherence when complemented by robust monitoring frameworks (Rwanda Energy Group, 2021; SMEC, 2021). The World Bank (2020) further emphasizes that performance-based budgeting and lifecycle cost planning are essential tools for sustaining financial resource efficiency in PPP infrastructure projects.

Human resource and stakeholder coordination challenges further compounded project inefficiencies. Interview respondents identified dependence on foreign technical consultants, weak knowledge transfer mechanisms, and inadequate skills in PPP contract management as systemic barriers to effective human resource utilization (Zawawi & Kamaruzzaman, 2020; Chileshe et al., 2023). Stakeholder analysis revealed persistent trust deficits between public entities and private contractors, often manifesting in communication breakdowns and conflicting project priorities (El-Gohary et al., 2016; Akinmoladun & Oke, 2020). The Kigali Convention Centre and Kigali Bulk Water Supply projects illustrate how structured coordination frameworks and centralized PPP units can partially overcome these barriers, though approval delays and regulatory bottlenecks remain unresolved systemic constraints (Rwanda Development Board, 2021; African Development Bank, 2020; World Bank, 2019). Adoption of digital monitoring tools such as BIM and ERP systems was identified as a high-priority intervention to enhance real-time resource visibility and stakeholder accountability (Liu et al., 2020; Kavishe & Chileshe, 2020).

**Table 1: Key Resource Management Challenges Identified**

Challenge	Frequency (%)	Impact
Inconsistent Funding	67%	Delays & Cost Overruns
Lack of Transparency	72%	Resource Underutilization
Communication Gaps	74%	Coordination Failure

## 10. CONCLUSIONS

This study concludes that resource management remains a critical determinant of Public–Private Partnership (PPP) project performance in Rwanda's construction sector. Despite a strong legal and institutional framework, challenges persist in human, financial, and material resource allocation. Key issues include skills gaps in PPP contract management, limited feasibility study financing, dependence on foreign expertise, supply chain constraints, and bureaucratic delays.

Empirical evidence from surveys, interviews, focus groups, and case studies confirms that ineffective resource coordination contributes significantly to project delays and cost overruns (Akomea-Frimpong et al., 2023; Olawale & Sun, 2020). However, Rwanda has demonstrated notable progress through strategic alignment with Vision 2050 and NST frameworks, blended financing models, and structured PPP governance under the revised PPP Law (Rwanda Development Board, 2021). Strengthening institutional capacity, improving stakeholder coordination, adopting digital management tools, and implementing standardized resource frameworks are essential to enhance efficiency (Yescombe & Farquharson, 2018; OECD, 2019). Addressing these gaps will enable Rwanda to optimize PPP performance and accelerate sustainable infrastructure development (Nduhura et al., 2021; Ogunsola et al., 2024).

## 11. RECOMMENDATIONS

Based on the findings, several key recommendations are proposed to enhance resource management in Rwanda's PPP infrastructure projects:

1. Strengthen human capacity through continuous PPP training programs, professional certification, and structured knowledge transfer to reduce dependence on foreign consultants.

2. Implement financial management reforms including performance-based budgeting, improved feasibility study funding, blended finance mechanisms, and stronger fiscal risk assessment tools to enhance investor confidence.
3. Streamline regulatory processes by reducing bureaucratic delays, clarifying inter-agency roles, and digitalizing approval systems to improve efficiency and transparency.
4. Institutionalize stakeholder coordination through formal collaboration platforms, integrated project teams, and real-time digital monitoring dashboards to align objectives and improve communication.
5. Promote supply chain optimization by supporting local material production, adopting strategic procurement practices, and deploying BIM and ERP systems for project management.
6. Establish national PPP resource management guidelines, institutionalize lifecycle cost planning, and expand PPP capacity-building programs.

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