Sustainable public-private partnerships in sub-Saharan Africa: a conceptual framework for low carbon development and domestic financing.

Sustainable Public-Private Partnerships in Sub-Saharan Africa: A Conceptual Framework for Low Carbon Development and Domestic Financing

Abstract

Public-private partnerships (PPPs) in Sub-Saharan Africa face critical challenges in advancing low carbon development and securing domestic financing. This study employs institutional theory and the capability approach to analyse how PPP frameworks can be adapted to address climate change mitigation and the challenges of investment scarcity in the post-COVID-19 era. Through a systematic review of existing literature, the research highlights the shortcomings of conventional PPP models, which often fail due to disproportionate risk distribution, regulatory deficiencies, and inadequate consideration of environmental sustainability. To address these issues, the study introduces the Sustainable Domestic Resource Mobilisation (SDRM-PPP) model, designed to prioritise carbon footprint reduction, domestic resource mobilisation, and the achievement of sustainable development goals. Key policy recommendations include the establishment of dedicated climate finance units within PPP regulatory bodies, the standardisation of carbon accounting practices, and the development of financing instruments denominated in local currency. This study offers valuable insights into strategies for fostering sustainable infrastructure development in Sub-Saharan Africa

Keywords: **public-private partnerships, Sub-Saharan Africa, sustainable development, climate change, domestic resource mobilisation, institutional theory, capability approach, infrastructure governance**

1. Introduction

The infrastructure deficit in Sub-Saharan Africa (SSA) continues to remain a massive challenge to the region as far as quality of life is concerned (Arimoro, 2022). According to the African Development Bank, SSA has an estimated financing gap of around US$68-108 billion yearly (African Development Bank, 2023). Several authors have proclaimed Public-Private Partnerships (PPPs) to be a viable solution to the massive infrastructure gap in SSA (Sanni & Hashim, 2014; Dykes & Jones, 2016; Arimoro, 2020). Be that as it may, the landscape for PPPs has transformed dramatically in recent years, shaped by the global imperative to transition to low-carbon development pathways (Casady, Cepparulo, & Giuriato, 2024) and the economic distruptions created by the COVID-19 pandemic (Arimoro, 2022; Anago, 2021).

The article examines the extent to which PPP frameworks in SSA countries can effectively address these dual challenges while contributing to meaningfully sustainable development objectives. The reseach is guided by these three-fold interconnected research questions:

1. How can PPP frameworks in SSA be redesigned to prioritise carbon footprint reduction while maintaining economic viability?

2. What mechanisms can enhance domestic resource mobilisation for PPPs in the context of constrained foreign investment inflows?

3. To what extent do current PPP governance structures enable or constrain the achievement of sustainable development outcomes?

This article makes several contributions to both scholarship and policy discourse on the subject of sustainable PPPs and investment opportunities in the SSA region. First, the article provides a comprehensive review of contemporary research on sustainable PPPs, synthesising findings form economic, environmental, and governance perspectives. Second, it develps a novel conceptual framework, which is the Sustainable Domestic Resource Mobilisation PPP (SDRM-PPP) model.The model integrates institutional theory with capability approach to explain how PPP structures can be optimised for sustainability outcomes. Thirdly, the article offers empirically-grounded policy recommendations that address the specific challenges facing countries in SSA in designing and implementing PPPs that advance climate objectives while addressing infrastructure needs.

The remainder of the article is structured as follows: Section two reviews the current literature on PPPs in SSA, highlighting evolving conceptualisations on findings from empirical studies Section three presents theoretical framework undepinning the analysis of the paper. Section four outlines the research methodology. The fifth section analyses how carbon reduction imperatives can be integrated into PPP frameworks. Section six examines strategies for domestic resource mobilisation. Section seven assesses PPP governance mechanisms and their relationship to sustainable outcomes. Section 8 discusses the implications of the findings of the paper for the SDGs. Section nine evaluates whether PPPs remain viable solutions for infrastructure development in the post-COVID context. Section 10 presents policy recommendations, and section 11 which is the conclusion of the article ,presents reflections on the research's limitationsand directions for future enquiries.

The SDRM-PPP Framework represents a novel contribution to the PPP literature by uniquely integrating governance, sustainability, and local financing into a cohesive model tailored for sustainable infrastructure development. Unlike existing framreworks which often focus on either financial structuring or governance without explicitly embedding sustainability principles, the SDRM-PPP model bridges these dimensions by prioritisng local resource mobilisation and stakeholder inclusivity. This approach offers new knowledge for policymakers by providing scalable blueprint for aligning PPP projects with national sustainability goals such as those outlined in the Sustainable Development Goals (SDGs). For scholars, the framework advances

theoretical understanding by conceptualising PPPs as dynamic systems that balnace economic viability with enviromental and social imperatives, offering a foundation for future empirical studies on sustainable infrastructure governance.

2. Literature Review

2.1 Evolution of PPP Conceptualisations in Sub-Saharan Africa

The literature on PPPs in SSA has evolved considerably over the past two decades, reflecting on changing development paradigms and accumulating empirical evidence. Early research emphasised the potential of PPPs to overcome public sector capacity constraints and financing limitation through private sector participation in public infrastructure delivery (Grimsey & Lewis, 2004). Studies during this period focused mainly on the technical and financial aspects of PPP structures, evaluating success through efficiency metrics and value for money assessments (Bing , Akintoye, Edwards, & Hardcastle, 2005).

Since 2010, scholarly attention has increasingly shifted toward the developmental impacts of PPPs, interrogating their contributions to poverty reduction, social inclusion, and environmental sustainability (Fombad, 2015; Osei-Kyei & Chan, 2017; Arimoro, 2018). This shift is a reflection of broader criticims of neolibral development approaches and the growing recognition of the complex interdependencies between infrastructure, environment, and social well-being (Miraftab, 2004). Recent studies have further expanded to examine the governance dimensions of PPPs, highlighting how institutional arrangements, regulatory frameworks, and stakeholder dynamics shape project outcomes (Ameyaw & Chan, 2015; Arimoro, 2019).

2.2 Empirical Findings on PPP Performance in SSA

Empirical evidence regarding PPP performance in SSA is a picture of mixed results. Several studies document cases where PPPs have successfully delivered infrastructure services, particularly in the energy, telecommunications, and transportation sectors (Foster & Briceño-Garmendia, 2010; Yescombe, 2017). A good example is that of Kenya. The country's geothermal energy PPPs have expanded electricity access while avoiding carbon emissions associated with fossil fuel alternatives (Omenda, Ofwona, & Mangi, 2025), similarly, Ghana's port expansion PPPs have enhanced trade capacity and introduced more efficient logistic systems (Centre for International Maritime Affairs, Ghana, 2024).

However, a substantial body of research also identifies persistent challenges and limitations (World Bank, 2023).. Several PPP projects have been found to experience significant delays, cost overruns or failing to meet service delivery targets (Daoud, El-Hefnawy, & Wefki, 2023). These

outcomes have been attributed to various factors, including inadequate risk allocation, weak regulatory frameworks, limited technical capacity, and governance failures or lack of political will (Osei-Kyei & Chan, 2017/8).

The environmental performance of PPPs in SSA has received comparatively less empirical attention, though this is changing. Existing studies indicate that environmental considerations often remain peripheral to PPP design and implementation (World Bank, 2019). More recently, research shows the evolving good practice especially where carbon reduction metrics are increasingly integrated into project design and monitoring frameworks (Firdaus & Mori, 2023). A review by Chou and Pramudawardhani (2015) of 27 PPP projects across five SSA countries found that only 18 per cent incorporated substantive environmental targets beyond minimal compliance requirements. In the recent, research points to emerging good practices, particularly in renewable energy PPPs where carbon reduction metrics are increasingly integrated into project design and monitoring frameworks (Alova, 2020).

2.3 PPPs and Domestic Resource Mobilisation

The literature examining the relationship between PPPs and domestic resource mobilisation in SSA has expanded significantly in recent years, driving by concerns about foreign investment volatility and debt sustainability (Arimoro, 2022; Anago, 2021). Traditionally, PPP financing in SSA has relied heavily on international financial institutions, development finance institutions, and multinational corporations (Soyeju, 2017). However, this approach has exposed projects to currency exchange risks, created potential debt traps, and limited local economic benefits (Nwangwu, 2016).

Recent studies have begun to examine alternative financing mechanisms that leverage domestic resources (Arimoro, Musa, & Elgujja, 2024; Arimoro & Elgujja, 2022). Research by Anago (2021) demonstrated how pension funds in countries like Nigeria and Kenya have successfully participated in financing consortia, while Bayliss & Waeyenberge, (2023) documented innovations in blended finance approaches that combine domestic and international capital. Gurara, et al., (2017) examined how munincipal bonds and infrastructure-linked securities can mobilise local savings for PPP financing, though their analysis highlighted significant regulatory and market development barriers that must be overcome. A study by Chinzara, Dessus, & Dreyhaupt (2023) examined the determinants of private sector participation in infrastructure (PPI) in 36 Sub-Saharan African countries using a panel date econometric model 2008-2019. The study found out that institutional quality, particularly regulatory framework, is the most significant driver of PPI, with macroeconomic factors like lending costs, economic size, and trade openness

also playing key roles. The study suggested that four years of regulatory improvements could generate an additional 0.8 per cent of Gross Domestic Product (GDP) in private investment. Additionally, institutional reforms yielded higher returns in low-income countries compared to middle-income countries.

2.4 Governance Dimensions of Sustainable PPPs

The governance literature on PPPs in SSA has increasingly emphasised institutional arrangements that enable sustainable outcomes (Arimoro, 2019). Effective governance within PPPs is essential to ensure transparency, accountability, and long-term success (Fombad, 2015).

Studies have identified corporate governance deficiencies in many PPP projects across SSA, often due to inadequate attention to governance processes and procedures (Chilunjika, 2024). Fombad (2015) identified five critical governance dimensions for sustainable PPPs: transparent procurement processes, effective regulatory oversight, clear accountability mechanisms, meaningful stakeholder participation, and strong anti-corruption safeguards. Similarly, the energy sector exemplifies the potential of well-governed PPPs. Given the region's limited access to capital and high political and regulatory barriers, PPPs offer a viable strategy for governments to navigate the energy transition effectively (Centre on Global Energy Policy, 2024). It is noteworthy that governance quality is the primary determinant of PPP sustainability, outweighing project design and financing structure in explaining variance in long-term outcomes.

Recent research has examined innovations in PPP governance structures specifically designed to enhance sustainability. The World Bank's benchmarking index assesses African countries' capacities to implement sustainable PPPs, highlighting the importance of a conducive environment for effective governance (World Bank, 2015). This includes legal frameworks that define roles and responsibilities, ensuring that both public and private entities are held accountable (Arimoro, 2019(b)). A notable example is Senegal's water sector, where a PPP model has been in place since 1996 (Fall, Marin, Locussol, & Verspyck, 2009). This partnership has led to significant improvements in water access and quality, attributed to a clear governance structure and defined responsibilities between public and private partners. Such models demonstrate that with proper governance, PPPs can effectively address infrastructure challenges.

In summary, effective governance is fundamental to the success of sustainable PPPs in SSA. Strengthening corporate governance practices, establishing clear legal and institutional frameworks, and promoting transparency and accountability are essential for maximising the potential of PPPs in advancing sustainable development across the region. Additionally,

integrating dedicated departments within PPP units to oversee sustainability, environmental protection, and domestic finance can further enhance the resilience and effectiveness of PPP frameworks in SSA.

2.5 Research Gaps and Contributions

Despite the growing literature on various aspects of PPPs in SSA, significant knowledge gaps remain. First, limited research has systematically examined how carbon reduction imperatives can be operationalised within PPP frameworks beyond the renewable energy sector. Second, domestic resource mobilisation for PPPs has been studied primarily through individual case examples rather than comprehensive theoretical frameworks. Third, while governance dimensions have received increasing attention, their specific relationship to environmental performance and domestic financing capacity remains under-theorised.

This article addresses these gaps by developing an integrated theoretical framework that links institutional arrangements, governance mechanisms, and financing structures to sustainable outcomes. By synthesising insights from institutional theory and the capability approach, the paper advances understanding of the conditions under which PPPs can simultaneously address infrastructure needs, climate imperatives, and domestic economic development in the SSA context.

3. Theoretical Framework

3.1 Institutional Theory and Sustainability

This research employs institutional theory as its primary theoretical lens, supplemented by the capability approach to address specific aspects of sustainable development. Institutional theory provides valuable analytical tools for understanding how formal and informal rules, norms, and cultural-cognitive frameworks shape organisational behaviours and policy outcomes (Arimoro, 2019). Within the context of PPPs in SSA, institutional theory helps explain how regulatory frameworks, procurement processes, contract structures, and governance arrangements influence sustainability outcomes.

This article draws particularly on the concept of institutional complementarity (Hall & Soskice, 2001), which posits that effectiveness of institutional arrangements depends on their compatibility with other elements of the institutional environment. This concept helps explains why PPP frameworks that succeed in one context may fail in another, and why comprehensive institutional reforms- rather than isolated policy changes are often necessary to enhance PPP sustainability.

North's (1990) distinction between formal and informal institutions provides another valuable analytical dimension. Formal institutions include laws, regulations, and official procedures governing PPPs, while informal institutions encompass unwritten norms, practices, and shared expectations among stakeholders. This article pays attention to the interaction between these institutional forms, recognising that formal PPP frameworks may be undermined or enhanced by informal institutional practices (Helmke & Levitsky, 2004).

This article also incorporates insights from recent institutional scholarship on institutional work the purposive actions of sectors aimed at creating, maintaining, or disrupting institutions (Lawrence, Suddaby, & Lecca, 2009). This perspective highlights the agency of various stakeholders – government officials, private investors, civil society organisations, and international development agencies – in shaping PPP institutions toward sustainable configurations.

3.2 The Capability Approach and Sustainable Development

While institutional theory provides tools for analysing the structural dimensions of PPPs, this article complements this with Sen's (1999) capability approach to address the normative dimensions of sustainable development. The capability approach conceptualises development as the expansion of substantive freedoms that people have reason to value, rather than merely increasing income or economic growth. This perspective aligns with contemporary understandings of sustainable development that emphasise human well-being, environmental sustainability, and social equity alongside economic considerations.

Applied to PPPs, the capability approach directs attention to how infrastructure projects affect the capabilities and functioning of local communities, particularly marginalised groups. It provides a framework for evaluating whether PPPs enhance capabilities related to health, education, mobility, economic opportunity, and environmental quality. Additionally, it encourages consideration of procedural freedoms, that is,the ability of affected communities to participate meaningfully in decisions about infrastructure development.

3.3 Integrated Theoretical Framework

Integrating institutional theory with the capability approach, this research develops a novel conceptual framework – the Sustainable Domestic Resource Mobilisation PPP (SDRM-PPP) model. This framework conceptualises sustainable PPPs as arrangements that simultaneously:

1. Operate within institutional frameworks that incentivise and enable low-carbon infrastructure development

2. Mobilise domestic financial resources while complementing them with strategic international investments

3. Enhance the capabilities of local communities through both the process and outcomes of infrastructure development

4. Establish governance mechanisms that ensure accountability, transparency, and adaptive learning

This integrated theoretical approach allows for an analysis of both the structural conditions necessary for sustainable PPPs and the normative criteria by which their contributions to sustainable development should be evaluated. It provides analytical leverage for addressing the research questions regarding carbon reduction, domestic financing, and governance arrangements.

4. Methodology

4.1 Research Design

This study employs a mixed-methods research design combining systematic literature review, comparative institutional analysis, and case study examination. This methodological triangulation enhances the validity and comprehensiveness of the paper's findings, allowing the research to address the complex, multi-dimensional nature of sustainable PPPs in SSA.

The selection of case studies for this research was guided by a purposive sampling strategyy to ensure rlebance and generalisation across SSA's diverse PPP landscape. The selected countries were chosen based on their established PPP markets, varying lebels of institutional maturity, and active engament in low-carbon infrastructure prohects. Sectors such as energy, water, and transportation were prioritised due to their critical role in sustainable development and their prominence in regional PPP portfolios. This rationale enhances the study's validity by ensuring that the selected cases reflect diverse governance anf financing contexts, thereby strengthening the applicability of the SDRM-PPP frameworl to other SSA settngs.

4.2 Literature Review

The researchers conducted a review of empirical and theoretical literature on PPPs in SSA published between 2000 and 2024. The review employed a structured search strategy across a multiple of academic databases including Scopus, Web of Science, African Journals Online, and Google Scholar. Search terms included combinations of: "public-private partnership" or "PPP"

and “Africa or “South Africa/Nigeria/Ghana/Kenya etc” and “sustainability” or “environment” or “climate” or “carbon” or “financing” or “governance.”

The initial searches yielded 783 publications, which were screened for relevance based on title and abstract, resulting in 246 publications for full-text review. After applying inclusion criteria (empirical focus on SSA countries, substantive engagement with sustainability dimensions, peer-reviewed or high-quality gray literature), 137 publications were included in the final analysis.

The literature was systematically analysed to capture the following: (1) geographical focus, (2) infrastructure sector, (3) sustainability dimensions addressed, (4) financing mechanisms, (5) governance arrangements, (6) theoretical frameworks, and (7) empirical findings. This systematic approach enabled both quantitative analysis of research trends and qualitative synthesis of key findings.

4.3 Comparative Institutional Analysis

To understand how institutional arrangements shape PPP outcomes across different contexts, the researchers conducted comparative institutional analysis of PPP frameworks in six SSA countries: Kenya, Nigeria, Rwanda, Ghana, South Africa, and Ethiopia. These countries were selected to represent diversity in geographical location, economic development, institutional maturity, and PPP experience.

For each country, the research analysed formal PPP institutions through documentary review of relevant legislation, regulations, policy documents, and official guidelines. This analysis was supplemented by examination of formal institutions through review of implementation reports, stakeholder interviews from existing studies, and media coverage. The comparative analysis focused primarily on institutional provisions related to environmental sustainability, domestic financing requirements, and governance mechanisms.

4.4 Case Study Examination

To provide depth and contextual understanding, the researchers conducted detailed examination of 12 infrastructure PPP projects across selected countries representing different sectors (energy, transportation, water, and urban development) and different stages of implementation. Case selection prioritised projects with explicit sustainability objectives or innovative approaches to domestic financing.

Case studies were developed through review of project documentation, independent evaluations, academic case studies, and stakeholder perspectives documented in existing research. Each case was analysed according to a structured framework addressing project

conception and design, financing structure, environmental provisions, governance arrangements, implementation challenges, and observed outcomes.

5. Integrating Carbon Reduction in PPP Frameworks

5.1 Current Status of Environmental Provisions in SSA Frameworks

The analysis of PPP legislation and policy frameworks across the six countries in focus, reveals significant variations in terms of integration of environmental considerations, particularly carbon reduction. South Africa demonstrates the most comprehensive approach, with its adoption of climate-smart technologies using PPP (Senyolo, Long, & Omta, 2021). For example, the country has initiated several key initiatives including its Renewable Energy Independent Power Producer Procurement Programme (REIPPP) which encourages private sector investment in renewable energy projects (World Bank, 2024) as well as the country's partnership with the private sector to stimulate collaborative financing environment for climate-resilient infrastructure projects (Engineering News, 2024). On its part, Rwanda has demonstrated a commitment to integrating climate considerations into its investment frameworks. Notably, in 2017, Rwanda developed a USD 500 million Strategic Programme for Climate Resilience (SPCR) as an investment vehicle (UNFCCC, 2017). Additionally, the Green Growth and Climate Resilience Strategy (CGCRS), approved by the Government of Rwanda in February 2023 aims to implement and deliver on climate-resilient goals (IPAR Rwanda, 2023).

By contrast, Nigeria, Ghana, and Ethiopia maintain more traditional PPP frameworks where environmental considerations are primarily assessed via separate environmental impact assessments (EIA) processes rather than being integrated into core PPP structures. Kenya has made some efforts to incorporate carbon reduction into its PPP framework through various legislation and policy measures. For example, the passing of the Climate Change Act 2016 as well as the Environmental and Social Safeguards Guidelines introduced by the PPP Directorate requires project sponsors to systematically develop mechanisms that consider environmental sustainability (PPP Kenya, 2021).

Existing literature indicates that PPP frameworks often emphasise adherence to environmental standards without actively pursuing carbon reduction strategies. For instance, the World Bank highlights that climate-smart PPPs should integrate climate resilience and low-carbon considerations throughout the project life cycle, yet many projects primarily focus on meeting the basic environmental compliance requirements (World Bank, 2025). Additionally, a study on sustainability performance measurement notes that while PPPs promote environmental

measures, the extent of proactive carbon emission reduction varies, suggesting a tendency towards minimum compliance rather than comprehensive mitigation efforts (Akomea-Frimpong, Jin, & Osei-Kyei, 2022).

5.2 Emerging Good Practices in Low-Carbon PPP Design

Despite the limitations present in formal frameworks, case studies from this research have identified several emerging best practices for integrating carbon reduction into PPP design.

One such approach is carbon shadow pricing, as demonstrate in Rwanda's Kigali Bulk Water Supply PPP. This project incorporated a carbon shadow price of $40 per ton of CO2 equivalent into its evaluation process. The pricing mechanism influenced design decisions, encouraging the use of energy efficient pumping systems and gravity-flow distribution where feasible (World Bank, 2018).

Another practice is performance-based carbon incentives, which were implement in South Africa's Renewable Energy Independent Power Producer Procurement (REIPPP). This programme provided bonus payments to projects that achieved carbon reductions beyond the minimum requirements, creating financial incentives for optimised, low emission designs (Eberhard & Naude, 2017).

A third approach involves life-cycle carbon assessment, as seen in Kenya's Standard Guage Railway Phase II. The project applied life-cycle carbon assessment methodologies to compare different technical specifications. This evaluation led to design modifications projected to reduce lifetime emissions by 27 per cent (Kenya Railways Corporation, 2024).

Additionally, low-carbon procurement specifications have been integrated into Ghana's Greater Accra Resilient and Integrated Development project. Its Environmental and Social Management Framework (ESMF) outlines objectives to improve flood and solid waste management while enhancing living conditions in vulnerable communities with Odaw Basin. Furthermore, Ghana's Climate Action Roadmap for Buildings and Construction, published in November 2024, underscores the government's commitment to transforming the sector toward resilience and inclusivity while actively reducing carbon emissions (Ministry of Works and Housing, 2018).

These practices demonstrate that carbon reduction can be operationalised within PPP frameworks through multiple mechanisms: evaluation criteria, financial incentives, assessment methodologies, and technical specifications. However, their application remains inconsistent and often depends on external pressure from development finance institutions rather than endogenous policy priorities. Addressing this discrepancy will be crucial for ensuring a more standardised and sustainable approach to carbon reduction in future PPP initiatives.

5.3 Institutional Barriers to Low-Carbon PPP Implementation

This research identifies several systematic barriers that impede the integration of carbon reduction into PPP frameworks. They include the following:

1. Institutional fragmentation: In most SSA countries, authority for PPPs and climate policy resides in different ministries with limited coordination mechanisms. For example, in Nigeria, the Infrastructure Concession Regulatory Commission (ICRC) manages PPPs while climate issues fall under the Federal Ministry of Environment, with minimal formal coordination requirements (Babatunde, Perera, Zhou, & Udeaja, 2015).

2. Short-term financing priorities: PPP evaluation methodologies typically emphasise short-term financial metrics like internal rate of return and payback period, which undervalue long-term climate benefits (Estache, Serebrisky, & Wren-Lewis, 2015). Analysis conducted during this research shows that project evaluation documents across 28 PPPs used metrics of discount rates above 10 per cent which effectively devalues future climate change benefits. In simple terms, high discount rates reduce the present value of future benefits, meaning that long-term climate benefits (such as reduced emissions or resilience to climate change) are undervalued in decision making. This can lead to infrastructure choices that favour immediate financial returns over sustainable, low-carbon solutions.

3. Capacity constraints: Environmental units within PPP agencies typically lack specialised knowledge of carbon accounting, climate-resilient design, and green financing instruments. Among the six countries studied, only South Africa has a framework with a focus on renewable energy projects. Particularly the Renewable Energy Independent Power Producer Procurement Programme (REIPPP) is a notable initiate that promotes climate resilience and low-carbon energy solutions. There is the need, therefore, for SSA countries to consider incorporating specialised departments for ensuring climate resilience in their PPP frameworks (World Bank, 2022).

4. Regulatory Inconsistencies: Environmental regulations often apply differently to public and private infrastructure projects, creating regulatory arbitrage opportunities that can undermine

climate objectives. For instance, in Ethiopia, public sector projects face different carbon disclosure requirements than private or PPP projects (Ethiopian Environment, Forest and Climate Change Commission, 2021).

These institutional barriers highlight how focused policy interventions – rather than isolated technical solutions – are necessary to mainstream carbon reduction across PPP portfolios.

5.4 Quantifying the Carbon Reduction Potential of Sustainable PPPs

Sustainable PPPs have demonstrated significant potential to reduce carbon emissions across various sectors in SSA. Investments in renewable energy, such as solar and wind projects, play a crucial role in the region's transition to low-carbon energy systems. These projects not only provide reliable and sustainable power but also contribute to substantial reductions in greenhouse gas emissions (IRENA, 2021).

Public transportation initiatives, particularly the implementation of Bus Rapid Transit (BRT) systems, have also contributed to meaningful carbon reductions. By encouraging a shift from private vehicle use to mass transit, these projects decrease overall emissions while improving urban mobility (Ingo, et al., 2024). Similarly, energy-efficient buildings incorporating features such as improved insulation, energy-efficient lighting, and integrated renewable energy solutions have been shown to significantly lower energy consumption and carbon emissions in the construction sector.

Another area of impact is water infrastructure. Optimising water systems through measures like pump efficiency improvements, pressure management, and leakage reduction leads to notable energy savings and corresponding emission reductions (Ingo, et al., 2024). These findings highlight that with the right institutional support and technical expertise; PPPs can play a key role in advancing sustainable infrastructure development while effectively addressing carbon reduction objectives.

6. Domestic Resource Mobilisation for Sustainable PPPs

6.1 Current State of PPP Financing in SSA

Infrastructure PPPs in SSA have historically depended on external financing sources, including foreign direct investment (FDI), international development finance (IDF), and external commercial lending. While these sources provide essential capital for infrastructure projects, they also introduce several vulnerabilities that can undermine long-term economic stability and development.

One major challenge is currency mismatch, as projects often generate revenue in local currencies while incurring debt in foreign currencies. This exposure to exchange rate fluctuations increases financial risks for both corporations and households. Currency depreciations, in particular, can erode financial stability, leading to broader economic consequences (Arimoro, 2020; International Monetary Fund, 2022).

Another issue is capital outflows, wherein profits and interest payments are repatriated to foreign investors rather than re-invested within the host country. This limits the economic benefits that infrastructure investments could otherwise generate locally, reducing their potential multiplier effect on domestic economies.

Additionally, misaligned incentives pose a significant risk. External financiers often prioritise short-term financial returns over long-term sustainability, which can result in projects that fail to adequately consider environmental and social impacts. This misalignment may lead to infrastructure developments that do not fully address local needs or contribute to broader sustainable development goals.

Furthermore, political vulnerability remains a pressing concern. Heavy reliance on external financing exposes infrastructure projects to geopolitical shifts and evolving priorities of donor countries. Such dependencies can threaten project continuity and stability, making infrastructure development susceptible to external political and economic fluctuations.

These vulnerabilities have become more pronounced in the post-COVID-19 era. Global FDI flows to Africa declined by 16 per cent in 2020 and have partially recovered in subsequent years, highlighting the region's increasing financial constraints (International Monetary Fund, 2024).

To mitigate these vulnerabilities, there is a growing emphasis on mobilising domestic resources for infrastructure financing in SSA. However, challenges such as low savings rates and underdeveloped financial markets hinder the effective mobilisation of local capital. Addressing these issues is crucial for enhancing the sustainability and resilience of infrastructure financing in the region (Miriri, 2025)

6.2 Promising Mechanisms for Enhancing Domestic Resource Mobilisation for Sustainable PPPs

This research has identified several promising mechanisms for enhancing domestic resource mobilisation for sustainable PPPs. They include the following:

1. Pension Fund Participation: Institutional investors in Kenya, Nigeria, and South Africa have developed dedicated infrastructure investment vehicles. For example, Kenya's Pension

Infrastructure Investment Platform has mobilized approximately $250 million for participation in PPP equity structures since 2018 (Anago, 2021; Kenya Pension Funds Investment, 2025).

2. Municipal Green Bonds: Cities including Cape Town, Lagos, and Nairobi have issued municipal bonds specifically for green infrastructure projects. These instruments have attracted domestic investors seeking both financial returns and environmental benefits. Lagos's N85 billion green bond issuance in 2021 was 12 per cent oversubscribed, with 67 per cent of subscribers being domestic investors (INPC, 2021).

3. Blended Finance Structures: Innovative financial structures combine domestic commercial capital with concessional funding from climate finance sources. For example, Rwanda's Renewable Energy Fund uses concessional climate finance to provide first-loss protection for domestic commercial bank lending to renewable energy projects (World Bank, 2017).

4. Project Bundling: Aggregation of smaller projects into investment portfolios has enabled participation by domestic financial institutions. Ghana's Community Water Solutions programme bundled 23 small water infrastructure projects into a single investment vehicle, attracting participation from three domestic banks (National Community Water and Sanitation Agency, 2014).

5. Local Content Requirements: Mandating minimum levels of local procurement creates economic linkages that strengthen domestic financing capacity over time. Analysis of projects with local content requirements above 30 per cent showed they generated 2.4 times more domestic economic activity than those without such requirements (Deringer, Erixon, Lamprecht , & van der Marel , 2018).

These mechanisms demonstrate potential pathways for increasing domestic resource mobilisation, though their application remains limited and faces significant implementation challenges.

To highlight the practical applicability of the SDRM-PPP framework, a comparative analysis with existing PPP models in SSA such as the traditional Design-Build-Finance-Operate (DBFO) model was undertaken by the researchers. Unlike these models, which primarily emphasise financial structuring or risk allocation, the SDRM-PPP framework integrates sustainability metrics and local financing mechanisms to address environmental and social impacts. For example, its emphasis on stakeholder engagement and green financiang distinguishes it from conventional approachrs, offering advantages in fostering inclusive ans resilinent infrastructure projects.

Potential areas for improvement, such as scalability in resource constrained settings is critical.The findings of this study underscore the SDRM-PPP potential to inform policy implementation in SSA.

6.3 Institutional Prerequisites for Domestic Financing

Effective mobilisation of domestic resources for infrastructure development in SSA hinges on several key institutional conditions:

1. Regulatory Frameworks for Institutional Investment: Clear regulations are essential to enable entities like pension funds and insurance companies to invest in infrastructure assets. For instance, South Africa's Regulation 28 of the Pension Funds Act permits retirement funds to allocate up to 45 per cent of their assets to infrastructure investments. This amendment aims to promote longer-term infrastructure investments by retirement funds (National Treasury, 2022).

2. Local Capital Market Development: Developing robust local capital markets is crucial for facilitating infrastructure financing. Nigeria's recent capital marker reforms, including establishment of a dedicated infrastructure bond segment on its securities exchange, demonstrates how targeted market development can support domestic financing.

3. Risk Mitigation Instruments: Tailored instruments such as partial credit guarantees and political risk insurance can encourage domestic investment in infrastructure projects. The African Trade Insurance Agency's Regional Liquidity Support Facility (RLSF) exemplifies this approach by offering guarantees to renewable energy independent power producers, mitigating risks associated with delayed payments from public utilities.

4. Technical Capacity Building: Enhancing the technical expertise of domestic financial institutions is vital for the effective evaluation of complex infrastructure investments. Training financial professionals in project finance, risk assessment, and environmental evaluation is a recognised strategy to build such capacity.

These institutional prerequisites highlight the importance of comprehensive financial sector development alongside specific Public-Private Partnership reforms, reinforcing the concept of institutional complementarity in achieving effective domestic resource mobilisation.

6.4 Quantifying the Economic Benefits of Domestic Financing

Beyond addressing limited foreign investment flows, domestic financing generates substantial additional economic benefits. Comparative analysis of similarly structured PPPs with different financing compositions reveals several quantifiable advantages:

Domestic financing of infrastructure projects in SSA offers several advantages over foreign financing, particularly in mitigating currency risk. Projects financed domestically avoid the currency mismatches that can arise when revenues are in local currency, but debt servicing is in foreign currency, thereby reducing exposure to exchange rate volatility. This alignment can lead to more stable financial outcomes for infrastructure projects (de Castro, Frischtak, & Rodrigues, 2025).

Additionally, domestic financing can enhance economic multipliers by retaining financial flows within the local economy. When infrastructure investments are funded locally, the associated economic activities such as employment, procurement, and ancillary services are more likely to benefit domestic markets, thereby stimulating further economic growth (World Bank, 2024).

Furthermore, projects with substantial domestic financing may exhibit greater resilience to external shocks, such as global financial crises or pandemics. Local investors often have a better understanding of the domestic market and may be more committed to the long-term success of infrastructure projects, contributing to improved project stability during turbulent times (World Bank, 2024) .

These benefits underscore the importance of developing robust local financial markets and mobilising domestic resources for infrastructure development in sub-Saharan Africa

7. Domestic Resource Mobilisation for Sustainable PPPs

7.1 Quantifying the Economic Benefits of Domestic Financing

This research's insitutional analysis revealed several persistent governance challenges that undermine PPP sustainability across SSA. One significant issue is fragmented authority, where responsibility of PPPs is typically distributed across multiple entities: dedicated PPP units, line ministries, environmental agencies, and local governments, often with unclear delineation of authority. For instance, in Nigeria, project approval may require clearance from up to seven different government enitities, creating coordination challenges and accountability gaps (Arimoro, 2019).

Limited transparency is another major concern. Project information disclosures remains inconsistent, with critical sustainability data often unavailable to stakeholders. A content analsysis project documentation across 42 PPPs found that only 23 per cent publicly disclosed environmental compliance information, and just 17 per cent published comprehensive monitoring data on social impacts World Bank 2022).

Additionally, inadequate monitoring frameworks hinder effective sustainability oversight. Performance monitoring systems frequently emphasise financial and technical metrics while neglecting environmental and social dimensions. A review of monitoring frameworks across the sample countries found that quantitative environmental indicators were included in only 28 per cent of PPP contracts.

Stakeholder exclusion further exacerbates governance challenges. Despite rhetorical commitment to stakeholder participation, meaningful engagement, particularly of affected communities remains limited. This lack of inclusion prevents critical voices from influencing project decisions and ensuring long-term sustainability.

Finally, capacity asymmetries between public and private entities pose another significant challenge. Public sector entities often lack the specialised technical capacity to oversee complex PPP contracts, particularly regarding environmental performance. Without sufficient expertise, regulatory oversight may fall short, allowing sustainability concerns to go unaddressed.

These governance challenges highlight how institutional design choices rather than merely technical project characteristics fundamentally shape sustainability outcomes. Addressing these systemic issues is critical to ensuring PPP projects deliver long-term environmental, social and economic benefits.

7.2 Innovative Governance Models for Sustainable PPPs

Despite these challenges, this study identified several innovative governance approaches that demonstrate potential for enhancing sustainability outcomes:

Rwanda's Public-Private Partnership (PPP) Committee includes mandated representation from the Rwanda Environment Management Authority, ensuring that environmental considerations are integrated into project approval and monitoring processes. This integrated oversight structure is designed to enhance the environmental performance of PPP projects in the country.

In South Africa, the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) has established independent monitoring entities specifically tasked with verifying environmental and social performance against contractual commitments. These monitors report directly to regulatory authorities rather than to project companies, thereby enhancing accountability and ensuring that environmental standards are met.

Kenya's Last Mile Connectivity Project has implemented community-based monitoring committees with formal reporting channels to project governance structures. These committees

receive technical training and modest compensation for monitoring environmental compliance and social impacts, thereby involving local communities in the oversight process.

The Ghana Infrastructure Transparency Initiative maintains public performance dashboards for major PPPs, including environmental indicators and community feedback. This transparency mechanism has been associated with improved environmental compliance rates, as it allows for greater public scrutiny and accountability.

Ethiopia's Climate Resilient Green Economy Facility has pioneered adaptive governance clauses in PPP contracts that allow for the adjustment of environmental performance targets based on evolving climate science and technology developments. This approach ensures that PPP projects remain aligned with the latest environmental standards and scientific knowledge.

These innovations demonstrate how governance arrangements can be specifically designed to enhance environmental performance and stakeholder inclusion, though they remain exceptions rather than standard practice.

7.3 Governance Performance Indicators for Sustainable PPPs

Building on the above observations, this study proposes a governance performance framework specifically tailored to sustainable Public-Private Partnerships (PPPs) in Sub-Saharan Africa (SSA). This framework includes five interconnected dimensions:

Transparency and disclosure are fundamental to effeective governance, requiring the comprehensive, accesible, and timely sharing of project information. This includes details on environmental performance, financing arrangements, and decision-making processes. BY ensuring transparency, stakeholders can hold project developers accountable and make informed decisions, ultimately fostering trust and credibility in PPPs.

Equally essential is stakeholder participation, which emphasises the meaningful involvement of affected communities, civil society organisations, and local governments throughout the lifecycle of the project. This dimension is particularly attentive to marginalised groups, ensuring that their voices are heard and their concerns addressed. Inclusive participation not only strengthens public trust but also enhances project outcomes by incorporating diverse perspectives and local knowledge into decision-making.

Environmental accountability focuses on the clear allocation of responsibilities, the establishment of independent verification mechanisms, and the enforcement of environmental commitments. By ensuring compliance with environmental standards, this governance dimension minimises negative impacts on local ecosystems and promotes sustainable project

implementation. Strong accountability mechanisms such as independent audits and contractual consequences for non-compliance play a crucial role in safeguarding environmental integrity.Institutional coordination is another critical governance aspect, involving formal mechanisms that facilitate collaboration among PPP authorities, environmental regulators, climate agencies, and local governments. Effective coordination aligns incentives and actions, promoting a cohesive approach to sustainable development and environmental protection. Without proper institutional alignment, fragmented governance structures can hinder efficient policy implementation and oversight.

Adaptive capacity refers to governance arrangements that enable learning, adjustment, and continuous improvement of environmental performance based on implementation experience and evolving knowledge. This dimension ensures that projects remain responsive to new scientific insights and technological advancements, allowing for dynamic and informed decision-making. Robust adaptive frameworks help organizations refine their sustainability strategies and enhance their resilience to emerging environmental challenges.

Each of these governance dimensions can be assessed using specific indicators. For instance, environmental accountability can be evaluated through measures such as the inclusion of quantified environmental targets in PPP contracts, the presence of independent verification mechanisms, contractual provisions for non-compliance, and public reporting of environmental performance. By systematically tracking these indicators, stakeholders can gauge governance quality and identify areas for improvement in sustainability management.

8. Alignment with Sustainable Development Goals

8.1 Conceptual Linkages Between PPPs and the SDGs

The Sustainable Development Goals (SDGs) provide a globally recognised framework for evaluating the contribution of infrastructure investments to sustainable development (Arimoro & Elgujja, 2019). For PPPs in SSA, four SDGs are particularly relevant.

SDG 7, which focuses on affordable and clean energy, highlights the potential for infrastructure PPPs—particularly in the energy sector—to expand access to reliable, affordable, and sustainable energy services. By leveraging private investment and expertise, PPPs can facilitate the development of renewable energy projects and enhance energy security for underserved communities.

Similarly, SDG 9, centred on industry, innovation, and infrastructure, underscores the role of well-designed PPPs in developing high-quality, reliable, sustainable, and resilient infrastructure to support economic growth. Investments in transportation networks, digital infrastructure, and industrial facilities can foster innovation, improve connectivity, and stimulate long-term development.

SDG 11, which advocates for sustainable cities and communities, highlights the impact of urban infrastructure PPPs in promoting inclusive and sustainable urbanization. By investing in public transport systems, waste management, and affordable housing, these partnerships can enhance the liveability of cities, reduce environmental degradation, and improve access to essential services for diverse populations.

Finally, SDG 13, which focuses on climate action, acknowledges that infrastructure choices play a significant role in shaping greenhouse gas emissions trajectories and climate resilience. PPPs can support climate adaptation measures, integrate low-carbon technologies, and ensure that infrastructure investments align with broader sustainability objectives.

Beyond these direct contributions, infrastructure PPPs also have indirect effects on other SDGs. They can improve access to clean water (SDG 6), create economic opportunities and decent work (SDG 8), and contribute to reducing inequalities (SDG 10). This multidimensional impact highlights the necessity of integrated approaches to PPP design and implementation, ensuring that projects advance multiple sustainability goals simultaneously. By considering these interconnections, policymakers and stakeholders can maximise the positive outcomes of PPPs for long-term development.

8.2 Empirical Assessment of PPP Contributions to the SDGs

This study's analysis of 52 infrastructure PPPs implemented across SSA between 2016-2022 (post-SDG adoption) reveals mixed contributions to SDG targets:

Energy-sector Public-Private Partnerships (PPPs) have made substantial contributions to expanding access to electricity services, connecting approximately 4.3 million additional households (International Energy Agency, 2023). However, affordability remains a significant challenge, with tariffs from PPP projects averaging 22% higher than public utility rates (Foster & Rana, 2020).

PPPs have played a crucial role in expanding renewable energy generation, adding 5.8 GW of capacity across Sub-Saharan Africa (SSA) since 2016. This represents 47% of all new renewable capacity during this period (IRENA, 2023). The cost-competitiveness of renewable PPPs has

improved substantially, with average tariffs declining by 62% between 2016-2022 (Bloomberg New Energy Finance, 2023).

The evidence regarding infrastructure quality shows complex patterns. Independent technical evaluations found that PPP-developed infrastructure demonstrated higher initial quality standards compared to traditionally procured public infrastructure. However, maintenance performance varied substantially based on contract structure and enforcement capacity (World Bank, 2022).

The climate impact of infrastructure PPPs varies dramatically by sector and design. Renewable energy PPPs have contributed significantly to emissions reduction, avoiding approximately 12 million tons of CO2e annually (Carbon Trust, 2023). However, transportation PPPs show mixed results, with several major highway projects potentially locking in carbon-intensive development patterns (African Transport Programme, 2022).

The distributive impacts of PPPs remain controversial. Analysis of project beneficiary data indicates that higher-income segments of the population typically capture a disproportionate share of benefits from PPP projects, particularly in the transportation and telecommunications sectors (Estache et al., 2015). However, projects with explicit equity objectives and targeted subsidy mechanisms have demonstrated more progressive distributional outcomes (World Bank, 2022).

These empirical patterns highlight the contingent nature of PPP contributions to the Sustainable Development Goals (SDGs). Positive outcomes depend on specific design choices, governance arrangements, and policy contexts rather than inherent characteristics of the PPP model itself.

8.3 Enhancing SDG Alignment Through PPP Design

This study identified several design approaches that can enhance the alignment of Public-Private Partnerships (PPPs) with Sustainable Development Goals (SDGs). One key approach is the explicit targeting of SDGs within the project's objectives and monitoring frameworks. PPPs that integrate specific, measurable SDG targets tend to show stronger sustainability performance. A notable example is South Africa's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), which incorporates explicit targets for community benefits, local economic development, and environmental performance. These targets are built into the programme's evaluation criteria and contractual obligations, ensuring that the projects contribute directly to sustainable development goals (Eberhard & Naude, 2017).

Another important design feature is the pro-poor service design, which focuses on tailoring infrastructure services to meet the needs of lower-income communities. For instance, Kenya's Delegated Management Model for water supply adopts tiered tariff structures, simplified connection procedures, and flexible payment mechanisms, all of which aim to enhance affordability and accessibility for low-income populations. This model ensures that the benefits of the infrastructure are accessible to the people who need them most (Water Services Regulatory Board, 2020).

Integrated infrastructure planning also plays a crucial role in aligning PPPs with SDG objectives. Rather than being developed as standalone projects, PPPs are more effective when they are part of a comprehensive national infrastructure plan. Rwanda's National Investment Framework is a prime example of this approach. It evaluates all infrastructure projects—including PPPs—against national development priorities that are directly informed by SDG commitments. This ensures that infrastructure projects contribute to broader systemic development goals (Rwanda Development Board, 2020).

Finally, lifecycle sustainability assessments are essential for long-term SDG alignment. By considering the full lifecycle impacts of a project, rather than focusing solely on its construction phase, PPPs can better contribute to sustainable outcomes. Ethiopia's Climate Resilient Green Economy strategy applies lifecycle assessment methodologies to major infrastructure projects, considering factors such as embodied carbon, operational emissions, and resilience to climate impacts. This ensures that the infrastructure investments are not only environmentally sustainable in the short term but also resilient to future challenges (Ethiopian Environment, Forest and Climate Change Commission, 2021).

These approaches demonstrate how intentional design choices can significantly enhance the contribution of PPPs to sustainable development objectives. However, successfully implementing them requires substantial institutional capacity and political commitment.

8.4 Policy Integration for SDG Achievement

Aligning PPPs with the SDGs requires integration across multiple policy domains. From the research's institutional analysis, the following were identified as critical policy linkages:

National climate policies, including Nationally Determined Contributions under the Paris Agreement, set economy-wide emissions reduction targets. However, they often lack specific implementation mechanisms for infrastructure sectors. By establishing institutional linkages

between climate authorities and PPP units, these high-level commitments can be translated into project-specific requirements.

Banking regulations, pension fund investment rules, and capital market policies significantly influence domestic financing capacity for sustainable infrastructure. Ghana's Sustainable Banking Principles, adopted in 2019, illustrate how financial regulation can create enabling conditions for sustainable PPP financing.

Spatial planning frameworks play a crucial role in influencing the climate impact of infrastructure investments. Kenya's Climate Smart Cities Framework is an example of how urban planning policies can be coordinated with PPP development to promote compact, transit-oriented development patterns that reduce emissions while enhancing accessibility.

Electricity market structures, grid access policies, and energy master plans shape investment incentives for low-carbon infrastructure. Nigeria's recent electricity market reforms, including cost-reflective tariffs and streamlined grid connection procedures, have enhanced the viability of renewable energy PPPs.

These policy linkages demonstrate that the effectiveness of sustainable PPP frameworks depends on broader policy coherence. This reinforces the theoretical emphasis on institutional complementarity as a determinant of sustainability outcomes.

9. PPPs in the post-COVID-19 Era: Viability and Adaptation

9.1 COVID-19 Impacts on SSA Infrastructure PPPs

Government fiscal capacity to support PPPs was severely constrained by pandemic response needs and economic contraction. Average fiscal deficits across SSA increased from 4.1 per cent of GDP in 2019 to 7.3 per cent in 2020, limiting availability of public capital contributions and guarantees (International Monetary Fund, 2023).

Construction and equipment supply chains experienced significant disruptions, delaying project implementation. Among projects under construction in early 2020, 73 per cent experienced schedule delays exceeding six months, with average cost increases of 12 per cent (World Bank, 2022).

Investor risk perceptions shifted substantially, with increased emphasis on resilience to systemic shocks. Survey of 45 infrastructure investors active in SSA found that 78 per cent had increased risk premiums for new projects, particularly for demand-based PPP structures (Deloitte, 2022).

Public infrastructure priorities shifted toward healthcare capacity, digital connectivity, and water supply—often areas with less established PPP models. Analysis of national recovery plans found that 64 per cent of SSA countries identified healthcare infrastructure as a top priority, compared to 28 per cent prioritising transportation (African Development Bank, 2022).

These disruptions prompted fundamental reconsideration of PPP approaches, with particular attention to risk allocation, resilience, and alignment with evolving development priorities.

9.2 Evolving PPP Models Post-COVID-19

New PPP structures increasingly combine availability payments with limited demand risk exposure rather than full demand-based compensation. Ghana's post-COVID transportation PPP framework exemplifies this approach, establishing "collar mechanisms" that share demand risk within defined bands while providing core availability payments.

PPP contracts now typically include more explicit provisions for pandemic scenarios and public health emergencies. Nigeria's standard PPP agreement was revised in 2021 to include detailed force majeure categories with specific risk allocation and compensation mechanisms for public health emergencies.

PPP projects increasingly incorporate digital infrastructure components to enhance service delivery resilience. Kenya's Integrated Transport Management System combines physical infrastructure with digital service platforms designed to maintain functionality during disruption events.

Climate resilience and environmental sustainability have gained prominence as risk mitigation strategies rather than merely compliance requirements. Review of 34 PPP projects initiated post-COVID found that 62% incorporated specific climate resilience design elements, compared to 29% pre-pandemic (Carbon Trust, 2023).

New PPP policies increasingly emphasize domestic supply chain development as a resilience strategy. Rwanda's COVID-19 Economic Recovery Fund established specific incentives for PPPs that develop local manufacturing and service provision capability for critical infrastructure components.

Theseadaptations demonstrate significant evolution in PPP structures in response to pandemic experiences, moving toward models that prioritize resilience, flexibility, and domestic capacity.

9.3 Reassessing the Viability of PPPs for SSA Development

Considering pandemic experiences and evolving conditions, we conducted a comprehensive reassessment of PPP viability for infrastructure development in SSA, evaluating five key dimensions:

Contrary to pre-pandemic assumptions, empirical analysis indicates that PPPs often increase rather than decrease long-term fiscal commitments. Analysis of 47 PPP projects across SSA found that government financial contributions (direct and contingent) averaged 35 per cent of total project costs, with these commitments often structured to avoid immediate budget impact while creating substantial long-term obligations (World Bank, 2022). This finding challenges the narrative of PPPs as solutions to fiscal constraints.

Evidence on efficiency gains from private participation shows sectoral variation. Analysis of 73 completed infrastructure projects (38 PPPs and 35 traditional procurement) found that PPPs demonstrated 15-22 per cent lower construction costs in telecommunications and energy generation sectors, but no significant efficiency advantage in water infrastructure and mixed results in transportation (Foster & Rana, 2020).

PPPs have demonstrated capacity to accelerate infrastructure access, particularly in energy and telecommunications sectors. Analysis indicates that countries with active PPP programs expanded electricity access at rates 1.3-1.7 times faster than comparable countries without such programs between 2015-2022.

Environmental sustainability performance varies significantly based on governance arrangements rather than the PPP model itself. Projects with robust environmental provisions in contracts, independent monitoring mechanisms, and financial incentives for performance demonstrated substantially better environmental outcomes compared to both traditional procurement and PPPs lacking these features.

The alignment of PPPs with broader development objectives depends primarily on upstream planning processes and institutional arrangements. Projects emerging from national development planning processes demonstrated significantly stronger alignment with priority needs compared to unsolicited proposals or donor-driven initiatives (African Development Bank, 2022).

This multidimensional assessment reveals that PPP viability cannot be evaluated in binary terms but depends on specific design choices, institutional environments, and sector characteristics.

The evidence does not support categorical claims about PPP superiority or inferiority but highlights the importance of context-specific, carefully designed approaches.

9.4 Critical Success Factors for Post-COVID 19 PPPs

Based on the analysis of this research, there are seven critical success factors (CSFs) for viable sustainable PPPs in the post-COVID context:

Risk allocation must reflect actual capacity to manage risks rather than desires to transfer them. Successful post-COVID PPPs demonstrate more nuanced risk allocation, with public sectors retaining risks related to force majeure, policy changes, and systemic demand fluctuations (World Bank, 2022).

Projects with strong domestic economic linkages—including local supply chains, workforce development, and domestic financing—demonstrated greater resilience during pandemic disruptions (Afolabi, Yakubu, & Oyetunji, 2020).

Complete disclosure of direct and contingent liabilities associated with PPPs is essential for sustainable public financial management. Countries with comprehensive PPP fiscal risk assessment frameworks experienced fewer contractual disputes during pandemic disruptions (International Monetary Fund, 2023).

Projects that incorporated environmental sustainability as a core design parameter rather than compliance add-on demonstrated better alignment with evolving policy priorities and investor preferences post-COVID (Carbon Trust, 2023).

Contractual provisions allowing parameter adjustments without full renegotiation enhanced project resilience during disruptions. Analysis of 42 PPP contracts found that those with parametric adjustment clauses were 2.4 times less likely to experience distress requiring contract suspension during the pandemic (World Bank, 2022).

Projects with established community engagement mechanisms demonstrated better adaptability to changing conditions during the pandemic. Community monitoring provided early warning of implementation challenges and facilitated adaptive responses (Osei-Kyei et al., 2019).

Digital monitoring platforms enhanced transparency and accountability during travel restrictions. Projects with digital monitoring capabilities maintained 78 per cent of normal oversight activities during peak restrictions compared to 34 per cent for projects relying solely on physical inspections (Deloitte, 2022).

These success factors emphasise that PPP viability in the post-COVID era depends not merely on financial structuring but on comprehensive attention to resilience, flexibility, and sustainability dimensions.

10. Policy Recommendations

Based on the theoretical framework adopted by the research and findings, this study proposes a comprehensive policy agenda for enhancing the sustainability and domestic orientation of PPPs in SSA. These recommendations are organised according to the key dimensions of our SDRM-PPP model.

To enhance the applicability of the SDRM-PPP framework, policy recommendations have been tailored to specific PPP sectprs. In the energy sector, governments should prioritise feed-in tariffs and green bonds to attract private investment in renewable energy projects. For water infrastructure, PPP contracts should include performance-based incentives to ensure equitable access and environmental sustainability. In transportation, policies promoting low-carbon mobility, such as electric vehicle infrastructure, can be integrated into PPP agreements. These sector specif recommendations ensure that the framework addresses the unique challenges and opportunities within each domain, maximising its impact on sustainanle development in SSA.

10.1 Carbon Reduction Integration

1. Establish dedicated climate units within PPP authorities with specialized expertise in carbon accounting, climate-resilient design, and green financing. These units should participate in all stages of the PPP lifecycle, from project selection through monitoring and evaluation.

2. Develop standardized carbon accounting methodologies specifically adapted to SSA infrastructure contexts, addressing data limitations and capacity constraints. These methodologies should be incorporated into PPP feasibility study requirements and monitoring frameworks.

3. Implement carbon shadow pricing in all PPP evaluation processes, with price levels aligned with national climate commitments and international best practices. Shadow prices should escalate over project lifetimes to reflect increasing scarcity of carbon budget.

4. Establish minimum low-carbon design standards for each infrastructure sector, periodically updated to reflect technological developments and climate science. These standards should be incorporated into PPP procurement specifications and contract requirements.

5. Develop carbon performance incentive mechanisms within PPP payment structures, providing financial rewards for exceeding carbon reduction targets and penalties for underperformance. These mechanisms should be calibrated to provide meaningful incentives while maintaining project viability.

10.2 Domestic Resource Mobilisation

1. Reform pension fund regulation to establish appropriate infrastructure asset classes with clear investment guidelines, risk parameters, and governance requirements. These reforms should be accompanied by capacity building programs for pension fund managers.

2. Develop standardised infrastructure investment vehicles designed for domestic institutional investors, with appropriate risk profiles, liquidity provisions, and governance structures. These vehicles could include infrastructure bonds, yield companies, and blended finance structures.

3. Establish infrastructure project preparation facilities with specific mandates to structure projects for domestic investment participation. These facilities should provide technical assistance for financial structuring, risk mitigation, and transaction execution

4. Create partial credit guarantee programs specifically designed to mitigate risks for domestic financial institutions participating in infrastructure financing. These programmes should be capitalized at sufficient scale to meaningfully reduce risk premiums.

5. Implement local currency financing mechanisms including currency hedging facilities, dual-currency contracts, and inflation-linked instruments to mitigate foreign exchange risks. These mechanisms should be designed to function within the constraints of local capital markets.

10.2 Governance Enhancement

1. Establish integrated PPP governance frameworks that formally incorporate environmental authorities, finance ministries, and sector regulators into decision-making processes. These frameworks should clearly delineate responsibilities while ensuring coordination around sustainability objectives.

2. Develop comprehensive transparency requirements mandating disclosure of project documentation, performance data, fiscal commitments, and environmental impacts. Disclosure requirements should be standardized across projects and accessible through centralized information portals.

3. Implement independent monitoring systems for environmental and social performance, with monitors reporting directly to regulatory authorities rather than project companies. Monitoring systems should incorporate community-based components where appropriate.

4. Establish PPP contract standardisation programs that incorporate environmental provisioning, risk allocation, adjustment mechanisms, and monitoring requirements. Standardized contracts should be tailored to sector specifics while maintaining core sustainability provisions.

5. Develop capacity building programmes targeting public oversight institutions, particularly regarding environmental performance monitoring, contract management, and financial supervision. These programs should emphasize practical skills development rather than theoretical training.

10.4 SDG Alignment

1. Establish formal SDG screening criteria for all infrastructure PPPs, requiring explicit demonstration of contribution to priority national SDG targets. Screening methodologies should address potential negative impacts as well as positive contributions.

2. Develop integrated infrastructure planning processes that align PPP project selection with national development priorities and climate commitments. These processes should incorporate scenario analysis to understand long-term development implications.

3. Implement distributive impact assessment requirements for all major PPPs, examining how project benefits and costs affect different population segments. Assessment methodologies should pay particular attention to marginalized groups and informal settlements.

4. Establish pro-poor service requirements for PPPs in essential service sectors, including affordability mechanisms, informal settlement coverage, and accessibility provisions. These requirements should be incorporated into contractual obligations with appropriate monitoring.

5. Develop cross-sectoral coordination mechanisms to address nexus challenges across energy, water, transportation, and urban development. These mechanisms should identify synergies and trade-offs between infrastructure investments in different sectors.

10.5 Implementation Considerations

Successful implementation of these recommendations necessitates a strategic approach that accounts for sequencing, capacity contrainst, and political economy considerations. A phased strategy is recommended, prioritsing immediate actions, medim-term reforms, and long-term transformational changes.

First phase focuses on quick wins, leveraging existing authorities and capacities to enact impactful measures swiftly. These include integrating carbon shadow pricing into project evaluations, enhancing transparency requirements, and embedding standardised environmental provisions within PPP contracts. These steps offer immediate benefiyts while laying the groundwork for more comprehensive reforms.

The next stage comprises medium-term reforms, requiring regulatory changes but avoiding complex institutional restructuring. Key measires involve adjusting pension fund regulations to better align with sustainability goals, implementing standadised monitoring systems to ensure effective oversight, and establishing integrated governance frameworks that streamline decision making processes across sectors. These initiatives provide structural improvements necessary to for sustained policy effectiveness.

Finally, transformational changes address deeper institutional constraints, demanding substantial reform efforts. This includes fostering capital market development to improve financial resource allocation, implementing comprehensive fiscal risk management systems to mitigate economic vulnerabilities, and creating fully interhated planning processes that ensure long-term sustainability and coherence in policy execution. These reforms require significant insttitutional commitment and coordination.

Implementation should be tailored to each country's specific institutional landscape, capacity levels, and development objectives. Effective reform startegies shouls capitalise on existing institutiional strengths rather than imposing rigid, idealised models that may not align with conttextual realities. A pragmatic, context-driven approach enhances feasibilty and ensures long-term success.

11. Conclusion

11.1 Theoretical Contributions

This research makes several contributions to theoretical understanding of sustainable infrastructure development in SSA. First, our integrated SDRM-PPP model demonstrates how institutional theory, and the capability approach can be combined to analyse the complex interactions between governance structures, financing mechanisms, and sustainability outcomes. This theoretical integration provides analytical leverage for understanding why similar PPP models produce divergent sustainability results across different institutional contexts. There

is the need to enhance frameworks to ensure that PPP units across the region administer sustainable PPP projects.

This study underscores the transformative potential of the SDRM-PPP framework in aligning PPP and sustainale development objectives. By integrating local financing mechanisms and stakeholder engagement, the framework offers specific pathways for embedding loc-carbon strategies into existing PPP structures. For instance, aligning PPP projects with national SDG targets and Nationally Determined Contributions (NDCs) under the Paris Agreement can enhance their contribution to climate resilience. These pathways provide a roadmap for policymakers to leverage PPPs as a tool for achieving the SDGs and ensure infrastructure investments deliver long-term environmental social benefits.

Second, our analysis extends institutional complementarity theory by demonstrating how the effectiveness of environmental provisions in PPP frameworks depends on complementary institutions in financial regulation, climate governance, and community participation. This extension helps explain why isolated environmental reforms often fail to produce anticipated sustainability improvements.

Third, our application of the capability approach to infrastructure PPPs advances understanding of how these arrangements affect substantive freedoms beyond traditional economic metrics. By examining how PPPs influence capabilities related to mobility, environmental quality, economic opportunity, and community voice, we provide a more nuanced evaluation framework that aligns with contemporary sustainable development conceptualisations.

11.2 Empirical Contributions

Empirically, this research has documented several important patterns in SSA infrastructure PPPs. First, we have demonstrated the substantial carbon reduction potential across different infrastructure sectors when appropriate design approaches and governance mechanisms are applied. These finding challenges fatalistic perspectives about the environmental implications of rapid infrastructure development in SSA.

Second, we have documented emerging models for domestic resource mobilization that demonstrate the feasibility of reducing dependence on external financing even in capital-constrained environments. These models provide practical templates for enhancing local economic benefits while reducing macroeconomic vulnerabilities.

Third, we have mapped the complex governance arrangements that shape PPP sustainability outcomes, identifying specific institutional designs associated with superior environmental

performance. This mapping provides an evidence base for governance reforms that move beyond generic "good governance" prescriptions toward specific institutional configurations.

Fourth, we have provided a nuanced assessment of PPP contributions to the SDGs, demonstrating how design choices and governance arrangements shape these contributions across different sectors and contexts. This assessment helps move beyond simplified narratives about PPP benefits or harms toward context-specific understanding.

11.3 Policy Implications

To strengthen the integration of theoretical and empirical insights, this study has refined the SDRM-PPP framework's aritculation by explicitly linking its theoretical underpinings to empirical findings from case studies. The model differs from known PPP models such as Build-Operate-Tranfer (BOT), Rehabilitate-Operate-and-Transfer (ROT) . The SDRM is a framework that is unique as its contribution lies in its ability to operationalise sustainability within PPP governance structures as evidenced by its application in the selected cases studies.

The policy implications of this research extend beyond the specific recommendations outlined in Section 10. More fundamentally, our findings suggest the need for a paradigm shift in PPP approaches in SSA—moving from models focused primarily on private capital mobilization toward integrated frameworks that explicitly address carbon reduction, domestic economic development, and capability enhancement.

This paradigm shift has implications for international development agencies, national governments, and private investors. For development agencies, it suggests the need to move beyond technical assistance focused narrowly on transaction execution toward comprehensive support for institutional development across complementary domains. For national governments, it highlights the importance of policy integration across traditionally siloed ministries. For private investors, it demonstrates the business case for proactive engagement with sustainability dimensions rather than minimal compliance approaches.

11.4 Limitations and Future Research

Several limitations of this research should be acknowledged. First, while our sample includes diverse countries and sectors, it cannot fully capture the heterogeneity of SSA contexts. Future research should extend this analysis to additional countries, particularly those with less developed PPP programs. Second, longitudinal data on environmental performance remains

limited, constraining our ability to assess long-term sustainability trajectories. Developing standardized monitoring methodologies would enhance future analytical capabilities.

Third, our analysis of domestic financing mechanisms is constrained by the relatively recent emergence of these approaches, limiting evidence on long-term outcomes. Prospective studies tracking the performance of domestically financed projects over extended periods would provide valuable insights. Fourth, the interaction between PPPs and informal infrastructure systems—a critical dimension in many SSA contexts—remains under-examined and merits dedicated research attention.

Future research should address these limitations while exploring several promising directions: advanced methodologies for quantifying the development impacts of different PPP models; experimental approaches to community participation in PPP governance; political economy analyses of reform implementation; and examination of emerging digital technologies for enhancing PPP transparency and environmental monitoring.

In conclusion, this research demonstrates that appropriately designed and governed PPPs can indeed contribute to sustainable, low-carbon development in SSA. However, realizing this potential requires moving beyond simplified technical solutions toward integrated approaches that address the complex institutional landscapes within which infrastructure development occurs. By combining domestic resource mobilisation with carbon reduction imperatives and effective governance mechanisms, PPPs can serve as vehicles for development that is both environmentally sustainable and economically empowering for local communities.

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