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The Role of Public-Private Partnerships (PPPs) in Strengthening Healthcare Supply Chains

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Abstract

Public-Private Partnerships (PPPs) are increasingly recognized as vital mechanisms for improving healthcare supply chains in low-resource settings. These partnerships bring together the strengths of the public sector—such as policy oversight and equity goals—with the private sector's efficiency, innovation, and logistical expertise. Healthcare supply chains in many low- and middle-income countries suffer from persistent challenges including inadequate infrastructure, fragmented delivery systems, funding shortfalls, and limited accountability. Through a structured literature review, this paper explores how PPPs can be leveraged to address these issues, with a focus on vaccine logistics and last-mile delivery. The paper discusses conceptual frameworks underpinning PPP models, identifies key operational strategies, and highlights examples from Nigeria, India, Kenya, Rwanda, and Senegal. These cases illustrate the impact of service contracts, digital tracking platforms, drone delivery systems, and informed push models in enhancing logistics performance. In addition to presenting the benefits of PPPs—including improved efficiency, accountability, and innovation—the paper also explores significant challenges such as regulatory gaps, donor dependency, and power asymmetries. Policy recommendations include the establishment of enabling legal frameworks, sustainable financing, stakeholder engagement, and robust monitoring systems. Overall, the findings support a strategic and evidence-based approach to PPPs as a pathway for strengthening healthcare logistics, particularly in environments constrained by resources and capacity limitations.

Keywords: *Cold Chain, Healthcare Logistics, Low-Resource Settings, Public-Private Partnerships (PPPs), Supply Chain Strengthening, Vaccine Distribution.*

Introduction

Access to essential medicines, vaccines, and health commodities is a cornerstone of effective healthcare delivery. However, in many low-resource settings, healthcare supply chains are plagued by chronic inefficiencies that hinder the timely availability of life-saving interventions. These challenges range from insufficient infrastructure and underfunded logistics systems to weak information flow and poor accountability mechanisms [1]. The COVID-19 pandemic further exposed the fragility of health supply chains globally, with low-income countries disproportionately affected due to their limited ability to respond to sudden surges in demand and disruptions in global manufacturing and transportation [2].

In recent years, there has been a growing recognition of the potential of Public-Private Partnerships (PPPs) as a strategic approach to overcoming these supply chain bottlenecks. PPPs refer to cooperative arrangements between public sector entities and private organizations aimed at delivering services or infrastructure that are traditionally provided by governments [3]. In the context of healthcare, PPPs leverage the efficiency, innovation, and operational capacity of the private sector to complement public health goals. They have been widely used to expand healthcare

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infrastructure, introduce new technologies, and streamline service delivery [4]. More recently, their application in health supply chain logistics has gained traction, particularly in vaccine distribution, warehousing, cold chain management, and last-mile delivery [5].

This paper focuses on the role of PPPs in strengthening healthcare supply chains in low-resource settings. It seeks to unpack the conceptual foundations of PPPs, examine real-world applications, and evaluate their impact on health system performance. The discussion is particularly relevant in light of ongoing global efforts to achieve Universal Health Coverage (UHC) and the Sustainable Development Goals (SDGs), which underscore the importance of equitable access to essential health services [6]. Through an analysis of best practices, policy frameworks, and empirical case studies, this paper contributes to the growing body of evidence supporting the structured and strategic use of PPPs in transforming health logistics systems in fragile and underserved environments.

Methodology of Literature Review

This paper employs a structured literature review methodology to gather, analyse, and synthesize scholarly and grey literature relevant to Public-Private Partnerships (PPPs) in healthcare supply chains. The purpose of the review is to establish a comprehensive understanding of the current state of knowledge, identify effective PPP models, and highlight gaps and opportunities in the implementation of such partnerships in low-resource settings.

Search Strategy The literature search was conducted using electronic databases including PubMed, Scopus, Web of Science, JSTOR, and Google Scholar. Grey literature was sourced from organizational websites such as the World Health Organization (WHO), Gavi, the Vaccine Alliance, the World Bank, PATH, UNICEF, and national health ministries. Keywords used in the search included combinations of terms such as "public-private partnerships," "healthcare supply chain," "vaccine logistics," "low-resource settings," "cold chain management," and "last-mile delivery."

Inclusion and Exclusion Criteria Inclusion criteria were set to prioritize literature published between 2005 and 2024, written in English, and focusing on low- and middle-income countries. Articles and reports were selected if they addressed conceptual, empirical, or policy-related aspects of PPPs in healthcare logistics. Excluded materials included studies lacking relevance to supply chains, opinion pieces without supporting data, and documents focused exclusively on clinical PPPs without a supply chain component.

Data Extraction and Analysis Selected articles were reviewed for content related to PPP design, implementation models, performance outcomes, governance mechanisms, and sustainability issues. Thematic analysis was conducted to categorize findings into conceptual frameworks, operational models, benefits and challenges, and policy implications. Case study examples were prioritized where they illustrated scalable or replicable models of PPPs in health logistics.

Limitations of the Review While efforts were made to ensure a comprehensive search, some limitations exist. First, language restrictions may have excluded relevant non-English publications. Second, reliance on publicly available reports may have introduced bias, as unsuccessful PPPs are less likely to be documented in the public domain. Despite these limitations, the review provides a rigorous and evidence-based foundation for analysing the role of PPPs in strengthening healthcare supply chains.

Conceptual Framework

Public-Private Partnerships (PPPs) in healthcare are rooted in the broader theory of collaborative governance, which emphasizes joint decision-making and resource sharing between public authorities and private entities

to achieve mutually beneficial outcomes. In the context of healthcare supply chains, PPPs are structured arrangements where private sector partners assume defined roles in managing specific components of the supply chain, such as procurement, warehousing, distribution, or information systems, under contractual agreements with public agencies [7].

The World Bank classifies PPPs based on their degree of private sector involvement and risk-sharing. These range from service contracts and management contracts to more integrated models like lease agreements, build-operate-transfer (BOT) schemes, and full concessions [8]. Each model varies in the extent of responsibility transferred to private actors and the duration of the partnership. For instance, a service contract may involve outsourcing last-mile distribution to a private logistics firm for a specific period, while a concession may grant private control over the entire cold chain infrastructure, including maintenance and expansion.

In healthcare logistics, the rationale for PPPs is grounded in the efficiency thesis, which posits that the private sector, driven by performance incentives and market competition, is often more adept at delivering operational efficiency, innovation, and responsiveness than traditional bureaucratic systems [9]. This is particularly critical in low-resource settings where public systems may lack technical expertise, up-to-date technology, or logistical infrastructure.

The healthcare PPP ecosystem is also influenced by the principal-agent theory, where the government (principal) delegates service delivery to a private partner (agent) under a framework of performance expectations, monitoring, and accountability [10]. To mitigate agency risks, such as cost inflation or service shortfalls, contracts must include key performance indicators (KPIs), penalties for non-performance, and mechanisms for dispute resolution.

Furthermore, the design and implementation of PPPs in healthcare must consider the broader political economy. Factors such as regulatory capacity, institutional trust, stakeholder alignment, and socio-political context shape the success or failure of PPP models. Countries with strong legal systems, transparent procurement frameworks, and stakeholder engagement processes are more likely to sustain effective partnerships [11].

This conceptual framing provides the foundation for understanding the mechanisms, assumptions, and contextual variables that underlie PPPs in healthcare supply chains. The next section explores real-world applications of these models through selected case studies from low- and middle-income countries.

Results

This section will be presented in two parts: Case Studies illustrating countries where Public-Private Partnerships (PPPs) have been successfully implemented to strengthen healthcare supply chains. These examples highlight different models, operational scopes, and contextual challenges while providing valuable insights for adaptation and replication. While the second part describes the enabling factors for the successes recorded.

Case Studies

Nigeria: Public-Private Logistics for Vaccine Delivery in Nigeria, the National Primary Health Care Development Agency (NPHCDA) partnered with private logistics firms through the Direct Delivery Project (DDP) to improve last-mile vaccine delivery in underserved regions. Under this PPP model, private contractors were responsible for transporting vaccines from state stores directly to primary health care centers on a pre-agreed schedule using temperature-controlled vehicles. This initiative reduced stockouts, improved delivery timeliness, and maintained cold chain integrity [12]. The program also used GPS tracking and

electronic proof-of-delivery systems to enhance transparency and accountability.

India: Electronic Vaccine Intelligence Network (eVIN) India's Ministry of Health and Family Welfare, with technical support from the United Nations Development Programme (UNDP), implemented the eVIN system—a technology-enabled PPP that digitizes vaccine logistics. Through mobile and cloud-based platforms, eVIN enables real-time monitoring of vaccine stocks and storage temperatures across over 27,000 cold chain points. Private IT firms manage the software infrastructure while public health officials manage field operations. The system has improved inventory management, minimized wastage, and streamlined resupply planning [13].

Kenya: Mission for Essential Drugs and Supplies (MEDS) In Kenya, the faith-based Mission for Essential Drugs and Supplies (MEDS) operates under a PPP model involving collaboration between religious institutions, the Ministry of Health, and donor agencies. MEDS serves as a central procurement and distribution agency for essential medicines and health supplies, reaching both public and private facilities. The organization applies stringent quality assurance practices and operates an advanced warehousing and distribution system [14]. The PPP has enhanced availability of quality medicines and increased access in rural areas.

Rwanda: Drone-Based Health Delivery with Zipline Rwanda's partnership with Zipline, a private drone delivery company, is one of the most celebrated examples of innovation in healthcare logistics. This PPP enables rapid delivery of blood products, vaccines, and medical supplies to remote health centers via drone technology. The government provides policy oversight and funding, while Zipline handles operations and technology management. The model has significantly reduced delivery times from hours to minutes, especially in hard-to-reach areas [15].

Senegal: Informed Push Model for Contraceptives Senegal adopted the Informed Push Model (IPM) to address chronic stockouts of contraceptives. Under this model, private logistics providers are contracted to deliver commodities directly to health facilities based on consumption data, rather than waiting for facility-generated orders. This shift from a passive to an active supply model resulted in a dramatic reduction in stockouts and improved data visibility and planning [16]. The government oversees policy and performance monitoring, while the private sector ensures efficient delivery.

These case studies underscore the versatility of PPPs in adapting to local health system needs and constraints. They demonstrate that with clear governance structures, appropriate technology, and mutual accountability, PPPs can significantly strengthen the performance of healthcare supply chains in low-resource environments.

Enabling Factors

To scale up and sustain effective Public-Private Partnerships (PPPs) in healthcare supply chains, particularly in low-resource settings, policymakers must adopt a strategic and inclusive policy environment. Successful PPP implementation is not merely a contractual arrangement but a governance process that depends on alignment of public health priorities with private sector capabilities.

Establishing an Enabling Legal and Regulatory Framework Governments must enact clear policies and legal instruments that outline the roles, responsibilities, and expectations of private partners in healthcare logistics. These frameworks should include standardized procurement procedures, contract templates, dispute resolution mechanisms, and compliance requirements [32]. Regulatory clarity helps build investor confidence and ensures consistency in implementation across jurisdictions.

Strengthening Institutional Capacity A core requirement for PPP success is the presence of capable public institutions. Ministries of Health and affiliated logistics agencies must be equipped with technical, legal, and financial expertise to design, manage, and monitor PPP contracts effectively [33]. This includes training staff in contract negotiation, risk assessment, and performance-based oversight. Capacity building can be supported through technical assistance from development partners and regional training hubs.

Encouraging Stakeholder Engagement and Transparency PPPs function best in environments where there is broad-based stakeholder support. Policymakers should involve civil society organizations, healthcare workers, donor agencies, and community leaders in the planning and evaluation of PPP projects. Public disclosure of contracts, pricing structures, and performance reports enhances transparency and mitigates the risk of corruption or misuse of funds [34].

Aligning PPPs with National Health Strategies PPPs should be embedded within broader national health strategies and not operate as standalone projects. This alignment ensures that private sector investments support national goals such as Universal Health Coverage (UHC), supply chain integration, and equitable access to services [35]. PPP initiatives must also be coordinated with existing vertical programs (e.g., immunization or HIV) to avoid duplication and promote system-wide efficiency.

Promoting Sustainable Financing Models To avoid dependency on donor support, PPPs should be backed by sustainable financing strategies. These may include pooled procurement, revolving funds, outcome-based financing, and insurance-based reimbursements [36]. Governments should incentivize long-term investment by offering risk-sharing mechanisms, tax breaks, or access to public infrastructure.

Implementing Robust Monitoring and Evaluation (M&E) Systems A strong M&E framework is critical to track PPP performance, assess cost-effectiveness, and ensure accountability. Governments should adopt digital tools for real-time data collection, define measurable performance indicators, and conduct periodic evaluations involving independent auditors or third-party evaluators [37]. Feedback from M&E processes should inform contract renegotiations and policy adjustments.

Service Contracts Service contracts involve outsourcing specific logistics functions—such as transportation or maintenance of cold chain equipment—to private providers for a fixed fee over a short-term period. These contracts are often used when governments seek to enhance operational efficiency without relinquishing strategic control. For example, Nigeria's Direct Delivery Project used service contracts with logistics firms to ensure reliable last-mile vaccine delivery [12].

Management Contracts Under management contracts, the private sector is responsible for managing entire supply chain operations, including human resources, inventory control, and fleet management. The public sector retains ownership and oversight but delegates day-to-day operations. This model has been applied in some sub-Saharan African countries to improve medical stores performance and optimize procurement cycles [27].

Concession Agreements Concession models transfer more extensive responsibilities to private entities, allowing them to operate, maintain, and sometimes finance infrastructure such as warehouses or distribution networks. The government defines the regulatory framework and performance indicators but does not engage in routine operations. These models are common in infrastructure-heavy supply chains and have been used to modernize central medical stores in countries like Zambia and Tanzania [28].

Build-Operate-Transfer (BOT) In the BOT model, a private company builds and operates a logistics facility for a specific period, after which ownership is transferred to the public sector. This model is suited for large-scale infrastructure projects, such as the construction of central cold chain warehouses or regional distribution centers. BOT arrangements can attract investment while ensuring long-term public ownership [29].

Social Franchising Social franchising involves a network of private providers operating under a common brand and adhering to standardized protocols and service agreements. In healthcare, this model has been used to ensure the delivery of high-quality services, including the distribution of family planning and essential medicines. Though more commonly used for service delivery, it has potential for application in last-mile commodity distribution [30].

Joint Ventures and Public-Private Logistics Hubs Joint ventures involve shared ownership and risk between public and private stakeholders. These arrangements often support large-scale warehousing or transportation infrastructure and promote shared investment in logistics capacity. Public-private logistics hubs have emerged in several countries to facilitate regional distribution of vaccines and other health products, often supported by multilateral agencies [31].

Each of these models can be customized to suit local needs, capacity levels, and policy frameworks. Effective implementation depends on careful contract design, stakeholder alignment, and robust performance monitoring systems. The following section explores policy considerations and strategic recommendations for scaling up PPPs in healthcare supply chains.

Discussion

The implementation of Public-Private Partnerships (PPPs) in healthcare supply chains yields both significant benefits and notable challenges. A comprehensive understanding of these dimensions is essential for designing PPPs that are not only effective in-service delivery but also sustainable and responsive to the evolving needs of health systems in low-resource settings.

Benefits

Improved Efficiency and Expertise Private sector entities often bring specialized skills, advanced technologies, and experience in logistics, procurement, and inventory management. Their inclusion enhances operational efficiency, reduces turnaround times, and supports data-driven decision-making [17]. In countries like India and Nigeria, PPPs have helped streamline vaccine distribution and improve cold chain monitoring through digital platforms and professional fleet management.

Cost-Effectiveness and Resource Mobilization PPPs can attract private capital and reduce the financial burden on governments. By engaging private partners in areas such as warehousing or transportation, governments can reallocate resources to other critical health system needs [18]. Additionally, donors and development agencies often favor PPP models due to their potential for scalability and impact.

Innovation and Technology Transfer The private sector is a key driver of innovation. PPPs allow for the introduction of cutting-edge technologies, such as drone deliveries, real-time temperature monitoring, and automated inventory systems, which would otherwise be inaccessible to the public sector [19]. These innovations have proven transformative, especially in settings with geographic and infrastructural constraints.

Enhanced Accountability and Performance Monitoring With performance-based contracts and service-level agreements, PPPs create a culture of accountability. Clearly defined roles, deliverables, and key performance indicators (KPIs) help ensure partners meet their obligations, and failure to do so results in

penalties or contract termination [20]. This contractual rigor often improves service delivery standards.

Strengthening Supply Chain Resilience By diversifying service providers and integrating private logistics systems with public infrastructure, PPPs reduce dependency on single supply chain channels. This diversification enhances system resilience, particularly during crises such as disease outbreaks or global supply disruptions [21].

Challenges

Regulatory and Legal Barriers Inadequate regulatory frameworks, weak contract enforcement, and lack of policy coherence can undermine PPP initiatives. The absence of clear guidelines for private sector engagement can lead to inefficiencies and conflicts [22]. Many countries lack experience in structuring complex PPP contracts, leaving room for ambiguity and disputes.

Power Asymmetries and Unequal Bargaining Power Private companies may have more technical expertise and negotiating leverage, potentially leading to contracts that disproportionately favour the private partner. This risk is heightened in contexts where public institutions are under-resourced or lack adequate legal and financial oversight [23].

Risk of Profit-Driven Motives Overshadowing Public Interest There is concern that private sector actors, motivated by profit, may prioritize cost-cutting or efficiency at the expense of equity or quality of care. Without robust monitoring and regulatory mechanisms, PPPs may exacerbate existing inequalities in healthcare access [24].

Sustainability and Donor Dependency Many PPPs in low-income countries are initiated with donor support or external funding. Once funding ceases, sustaining the partnership becomes challenging. Moreover, reliance on donor subsidies may delay the development of domestic capacity and financial independence [25].

Capacity Gaps in Public Sector Management Effective PPPs require skilled public officials capable of contract negotiation, monitoring, and performance evaluation. In many settings, public institutions lack this capacity, leading to ineffective oversight and suboptimal outcomes [26].

Understanding these benefits and challenges is key to designing PPPs that are both impactful and aligned with national health objectives. The next section explores the various operational models of PPPs that have been implemented globally.

Conclusion and Recommendations

Public-Private Partnerships (PPPs) are proving to be vital tools for addressing the longstanding and complex challenges facing healthcare supply chains in low-resource settings. As this paper has demonstrated, PPPs provide mechanisms for introducing technical expertise, improving efficiency, expanding access to innovative technologies, and enhancing accountability within supply chain operations. The case studies and operational models presented show the flexibility and adaptability of PPPs in diverse contexts and demonstrate their capacity to contribute to broader health system goals such as Universal Health Coverage and the Sustainable Development Goals.

However, the successful implementation of PPPs is not without challenges. Issues such as unequal bargaining power, weak regulatory environments, profit-driven motives, and limited public sector capacity can undermine the effectiveness and equity of these partnerships. Therefore, a structured and strategic approach to PPP design is essential. Policymakers must balance innovation and efficiency with safeguards to protect public interest, ensure transparency, and promote long-term sustainability.

Based on the findings in this paper, the following recommendations are proposed:

1. Governments should develop and adopt comprehensive legal and regulatory frameworks that clearly define PPP roles, responsibilities, and governance mechanisms.
2. Public institutions must be strengthened through investments in technical and managerial capacity, enabling them to design, negotiate, and monitor PPP contracts effectively.
3. Stakeholder engagement should be institutionalized at every stage of the PPP process, with mechanisms for transparency, community involvement, and public accountability.
4. PPPs must align with national health strategies and be integrated within existing systems rather than operating in isolation.
5. Innovative financing mechanisms such as revolving funds, pooled procurement, and outcome-based financing should be promoted to reduce donor dependency.
6. Continuous monitoring and evaluation should be implemented to assess performance, ensure accountability, and support adaptive management.

In conclusion, while PPPs are not a panacea for all healthcare supply chain problems, they offer a powerful means of bridging public sector gaps and mobilizing private sector capabilities. When thoughtfully designed and properly managed, PPPs can significantly enhance the resilience, responsiveness, and efficiency of healthcare logistics systems, ultimately improving health outcomes for populations in resource-constrained environments.

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Conflict of Interest

There are no conflicts of interest.

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