

Digital Public Goods: Concepts, Frameworks, Applications, and Future Directions

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Abstract: Digital public goods (DPGs) have gained considerable traction in global policy and development circles as a mechanism for advancing equitable, sustainable, and inclusive development worldwide. Broadly defined as open-source software, open data, open content, open artificial intelligence models, and open standards that adhere to privacy, security, and other applicable best practices, DPGs represent a transformative category of digital resources capable of addressing some of the most pressing developmental challenges of the twenty-first century. This review article synthesizes the extant literature on DPGs, tracing the evolution of the concept from its theoretical underpinnings in public goods economics to its contemporary operationalization through international frameworks such as the Digital Public Goods Alliance (DPGA) Standard. The article examines prominent sectoral applications in health, education, and public administration, drawing on case studies such as the District Health Information Software 2 (DHIS2) and OpenMRS. It also analyzes key challenges surrounding governance, sustainability, financing, data privacy, and digital inclusion, while discussing emerging policy directions. The review concludes that while DPGs hold significant promise as engines of development, their full potential can only be realized through coherent international coordination, robust domestic policy environments, sustainable funding mechanisms, and a commitment to inclusive design.

Keywords: digital public goods, open-source software, sustainable development goals, digital public infrastructure, global health informatics, digital inclusion.

1. INTRODUCTION

Over the past decade, the rapid proliferation of digital technologies has fundamentally reshaped how societies access information, deliver services, and address collective challenges. Within this transformation, the concept of digital public goods (DPGs) has emerged as a particularly compelling framework for harnessing the power of open, collaborative digital innovation in service of broader social objectives. Unlike proprietary digital products controlled by private entities for commercial purposes, DPGs are designed to be freely accessible, modifiable, and redistributable, thereby enabling countries—especially low- and middle-income nations—to build upon existing digital infrastructure without incurring prohibitive licensing costs.

The term 'digital public good' has been in circulation since at least 2017, when scholar Nicholas Gruen articulated the importance of building digital-age public goods. However, it was the United Nations Secretary-General's 2020 Roadmap for Digital Cooperation that gave the concept significant institutional momentum, explicitly calling for investments in open-source software, open data, open AI models, open standards, and open content that adhere to international best practices (United Nations, 2020). Since that landmark document, multilateral bodies including the United Nations Development Programme (UNDP), UNICEF, and numerous bilateral donors have mobilized resources and convened stakeholders to advance the DPG agenda globally.

The urgency of this agenda is underscored by twin global crises. First, progress toward the 2030 Sustainable Development Goals (SDGs) has been alarmingly uneven, with a widening implementation gap attributable in part to

resource constraints among developing nations. Second, approximately 2.6 billion people worldwide still lack internet access, with women in low-income countries disproportionately excluded from digital participation (UK Government, 2024). DPGs are increasingly seen as a means of addressing both challenges simultaneously—enabling developing countries to leapfrog proprietary dependencies while extending digital access to underserved populations.

This review article is organized as follows. Section 2 traces the theoretical foundations of the DPG concept. Section 3 describes the principal institutional frameworks and standards governing DPGs. Section 4 examines sectoral applications across health, education, and public administration. Section 5 addresses key governance, sustainability, and equity challenges. Section 6 surveys emerging policy directions and future research priorities. Section 7 offers a synthesizing conclusion.

2. Theoretical Foundations of Digital Public Goods

The intellectual lineage of DPGs traces back to foundational economic theory on public goods. Samuelson (1954) distinguished pure public goods from private goods on the basis of two properties: non-rivalry in consumption—meaning one person's use does not reduce availability for others—and non-excludability—meaning it is impractical to prevent any individual from accessing the good. Classic examples include national defense and clean air. In contrast, private goods are both rivalrous and excludable, giving rise to market-based provision.

Digital goods occupy an interesting position within this taxonomy. Software code, once written, can be reproduced at near-zero marginal cost, exhibiting strong non-rivalry. However, intellectual property regimes can render digital products excludable by design, as is the case with proprietary software protected by copyright and licensing restrictions. This bifurcation has generated enduring debates about optimal regimes for the production and distribution of digital knowledge goods (Kaul et al., 1999).

The DPG concept draws on this tension by advocating for deliberate institutional interventions—primarily open licensing—that remove excludability from digital products of broad societal value. Scholars such as Sahay (2019) have examined free and open-source software (FOSS) through the lens of global public goods theory, highlighting both its developmental potential and the structural distortions that prevent equitable access and sustainable maintenance. Nicholson et al. (2022) further extended this theoretical work by conceptualizing digital global public goods platforms for development, distinguishing them from conventional open-source projects by their explicit orientation toward collective social benefit in resource-constrained settings.

From an economic perspective, DPGs as impure public goods exhibit characteristics that neither fully conform to pure public goods theory nor to the logic of private markets. As noted in a 2022 UN Science-Policy Brief, digital public goods such as open-source software, data, and AI commons exhibit features of impure public goods, satisfying non-rivalry and non-excludability to a significant but incomplete degree (Gurumurthy et al., 2022). This impurity creates governance challenges: while anyone can in principle use a DPG, the free-rider problem threatens the sustainability of ongoing development and maintenance, since individual actors have weak incentives to contribute to collective digital resources from which they can benefit without contributing.

3. Institutional Frameworks and Standards

3.1 The Digital Public Goods Alliance and Its Standard

The most influential institutional actor in the DPG landscape is the Digital Public Goods Alliance (DPGA), a multi-stakeholder initiative co-hosted by the Norwegian Agency for Development Cooperation (Norad), UNDP, and UNICEF. Established to help discover and facilitate the deployment of open-source technologies, the DPGA operates the DPG Registry—a publicly accessible database of verified DPGs—and administers the DPG Standard, a set of nine indicators used to assess whether a digital solution qualifies as a DPG (Digital Public Goods Alliance, 2024). These indicators require that DPGs be: relevant to attaining the SDGs; utilize an approved open license; do no harm by design; advance best practices for data privacy, security, standards, and interoperability; and use open standards.

As of early 2023, 142 DPGs were listed in the DPGA Registry, the majority being open software (121), with the remainder comprising open data (14) and open content (15). The solutions predominantly target health (73), education (33), and reduced inequality (30), reflecting the priorities of the DPGA's development mandate (Oxford Global Society, 2023). By 2024, the Registry had grown further, and the DPGA launched improved tools including Roadmap pages, member profiles, and a digital self-assessment instrument to measure the scalability and readiness of individual DPGs.

The DPGA's governance structure embeds several important design principles. Membership has grown to include national governments—with Malawi, Ukraine, and Sierra Leone among recent joiners—multilateral bodies, civil society organizations, and private sector entities. This pluralistic composition is intended to balance diverse stakeholder interests and prevent any single actor from capturing the DPG agenda. The September 2022 adoption of the Digital Public Goods Charter further formalized these principles, with endorsements from governments, NGOs, and the private sector, signaling a growing international consensus around open, collaborative digital development (Digital Public Goods Alliance, 2022).

3.2 The United Nations Policy Ecosystem

Beyond the DPGA, DPGs are embedded within a broader UN policy ecosystem. The 2020 UN Roadmap for Digital Cooperation positioned DPGs as one of five core areas for global action, alongside connectivity, digital capacity building, digital human rights, and digital trust. In September 2024, the UN General Assembly adopted the Global Digital Compact (GDC), which explicitly recognized DPGs as enablers of SDG advancement and of digital public infrastructure more broadly (Digital Public Goods Alliance, 2024). This landmark multilateral instrument represents the most authoritative international endorsement of the DPG agenda to date.

The UN Technology Facilitation Mechanism (TFM), established under the 2030 Agenda, provides a complementary institutional platform for advancing DPGs through multi-stakeholder cooperation. The International Research Center of Big Data for Sustainable Development Goals (CBAS) has similarly championed DPGs as mechanisms for information-driven policy and decision-making related to SDG monitoring (Liang et al., 2023). This convergence across UN bodies and related institutions reflects the growing mainstream acceptance of DPGs as a policy instrument, even as scholarly debates about their definition, scope, and effectiveness continue.

3.3 Bilateral and Multilateral Donor Engagement

Bilateral donors and multilateral development banks have increasingly integrated DPGs into their digital development strategies. The UK Government's Digital Development Strategy 2024–2030 identifies DPGs as a core component of digital public infrastructure and explicitly references their role in advancing digital transformation, inclusion, and responsibility across partner countries (UK Government, 2024). The World Bank's Identification for Development (ID4D) initiative and its Digitalising G2P Payments (G2Px) program similarly leverage DPG solutions to extend financial inclusion and social protection in low- and middle-income countries, with the DPGA serving as a key collaborating partner (Digital Public Goods Alliance, 2024).

The UNDP has positioned itself as a leading champion of Digital Public Infrastructure (DPI), which it defines as the set of foundational digital systems forming the backbone of modern societies—encompassing identity, payments, and data exchange—many of which are built on DPG components (UNDP, n.d.). With presence in 170 countries and a global network of over 22,000 experts, UNDP works hand-in-hand with governments, businesses, and civil society to implement DPI that is safe, inclusive, and impactful, positioning DPGs as essential building blocks of this infrastructure.

4. Sectoral Applications of Digital Public Goods

4.1 Health Information Systems

Perhaps no sector has seen more consequential deployment of DPGs than health. Two platforms in particular—DHIS2 and OpenMRS—have achieved remarkable global reach and are frequently cited as leading examples of what well-designed DPGs can accomplish in resource-constrained settings.

DHIS2, developed and maintained by the HISP Centre at the University of Oslo, is a free, open-source, fully customizable platform for collecting, analyzing, visualizing, and sharing aggregate and individual-level data across health, education, and other domains (DHIS2 DPG Profile, n.d.). As of the end of 2022, DHIS2 was deployed by Ministries of Health in more than 75 low- and middle-income countries, with 69 of these nations implementing the platform at national scale (DHIS2, 2022). Beyond its core health information system functionality, DHIS2 has been extended to education, supply chain management, water and sanitation, nutrition, agriculture, and e-governance, demonstrating the versatile generativity that characterizes successful DPG platforms.

The platform's development is coordinated through a collaboratively planned, public roadmap, and DHIS2 software development operates in six-month release cycles with continuous application updates. Its financial sustainability is maintained through a coalition of global partners including Norad, PEPFAR, the Global Fund to Fight AIDS, Tuberculosis and Malaria, UNICEF, and Gavi, illustrating the multi-stakeholder funding arrangements typical of established DPGs (DHIS2, 2022). During the COVID-19 pandemic, DHIS2's adaptability was demonstrated in

Rwanda and other countries, where the platform was rapidly reconfigured to manage pandemic surveillance and response.

OpenMRS, an open-source electronic health record system initially developed for HIV monitoring and management, has been deployed in over 6,000 health facilities across more than 45 low- and middle-income countries, supporting the care of approximately 20 million patients (Mamlin & Cullen, 2018; Patel et al., 2023). Like DHIS2, OpenMRS demonstrates the agility and sophistication that well-maintained open-source platforms can provide. In Kenya, for instance, a small team required only one week to develop and deploy a COVID-19 tracking module built on the OpenMRS platform, without reliance on external vendors (Patel et al., 2023). This responsiveness to emergent needs illustrates a distinctive feature of DPGs: the ability of local communities to adapt globally developed tools to their specific contexts.

Research examining the implementation of DHIS2 and OpenMRS in Ethiopia has highlighted the importance of generative architecture, governance, and community as mechanisms for DPG platform adoption. The study found that while both platforms had been in active development for more than 20 years, the mismatch between global design assumptions and local contextual realities—including Ethiopia's unique calendar, over 80 local languages, and geographic connectivity challenges—required sustained local adaptation efforts (ResearchGate, 2025). This global-local tension is a recurring theme across DPG implementations and underscores the importance of context-sensitive deployment strategies.

4.2 Education and Open Educational Resources

The education sector has witnessed substantial DPG activity through the open educational resources (OER) movement, which has popularized copyleft licensing frameworks—particularly Creative Commons—that allow content to be freely reused, shared, modified, and redistributed. Because OER materials satisfy the openness criteria established by the DPGA Standard, they are widely classified as digital public goods. Scholarly analysis indicates that OER has contributed to reducing the costs of accessing learning materials in schools and higher education institutions across a range of countries, particularly in the Global South where textbook affordability poses a significant barrier to educational access (Wikipedia, 2026).

Among the DPGs listed in the DPGA Registry with an education focus, the African Storybook initiative exemplifies how open content can address language diversity and literacy gaps. By providing children's picture storybooks in numerous African languages under open licenses, this initiative demonstrates the potential for DPGs to address culturally specific needs that commercially driven publishing markets systematically neglect. The DPGA Registry records 33 DPGs specifically targeting education-related SDGs, reflecting the sector's prominence within the broader DPG ecosystem (Oxford Global Society, 2023).

4.3 Digital Identity and Public Administration

In the domain of digital public administration, the Modular Open Source Identity Platform (MOSIP) represents a prominent DPG aimed at supporting the creation of digital identity-linked products and services by both public and private organizations. Established in 2018 with support from the Omidyar Network, MOSIP provides governments with an open-source identity management system that can undergird a range of public service delivery functions, from social benefit distribution to voter registration and financial inclusion. As of 2024, approximately 7 million Zambians possessed a digitized identity card linked to MOSIP-based systems, enabling access to e-government portals and digital payment platforms (CSIS, 2025).

India's broader digital public infrastructure experience—often referred to as the 'India Stack'—offers instructive lessons about both the transformative potential and the risks of large-scale DPG deployment. India's Aadhaar biometric identity system, while not itself a DPG under the DPGA Standard's open-source requirement, has catalyzed a broader ecosystem that includes open-source components. By 2023, 161 countries had implemented some form of digital ID system, reinforcing the urgency of robust privacy and data protection safeguards as prerequisites for responsible DPG deployment (UK Government, 2024).

The UNDP's compendium on accelerating the SDGs through digital public infrastructure identifies several interaction effects among DPI components that amplify development impact. Combining a digital identity system with a digital payment platform and a shared data exchange layer can, when implemented with appropriate governance safeguards, unlock access to healthcare, education, and financial services for populations previously excluded from formal systems (UNDP, 2023). This systemic perspective on DPGs—as components of an integrated digital

infrastructure rather than isolated solutions—represents an increasingly influential framework in development policy circles.

5. Challenges and Critical Perspectives

5.1 Governance and Institutional Sustainability

One of the most persistent challenges confronting the DPG ecosystem is governance—the set of institutional arrangements that guide decision-making, resource allocation, accountability, and community management within individual projects and across the broader DPG landscape. Research conducted by Harvard Kennedy School's Ash Center on behalf of the Rockefeller Foundation identifies governance as simultaneously essential and expensive, noting that DPGs differ from conventional open-source projects in their explicit accountability to public benefit outcomes and their dependence on multi-stakeholder coordination (Bolte et al., 2022). The study emphasizes that DPGs require not merely technical excellence but strategic vision, stakeholder alignment, and institutional maturity to achieve their developmental potential.

Case study evidence from the implementation of DHIS2 in India illustrates the fragility that can arise when governance arrangements are inadequately institutionalized. Research documented a slowdown in project momentum following the transfer of a key institutional champion, underscoring that governance strength must be embedded in organizational structures rather than dependent on individual actors (Mukherjee et al., 2023). This finding resonates with the broader literature on open-source sustainability, which identifies organizational commitment and funding continuity as critical determinants of long-term project viability.

5.2 Financing and the Free-Rider Problem

The free-rider problem, well-established in public goods theory, manifests acutely in the DPG context. Because DPGs are non-excludable by design, individual actors—including governments, NGOs, and private sector entities—can benefit from DPG capabilities without contributing to their development or maintenance costs. This creates structural underfunding pressures that threaten the long-term sustainability of even well-established platforms. The 2022 consultations convened by the Digital Impact Alliance (DIAL) and the DPGA identified sustainable financing as a paramount challenge, recommending that incentive structures be designed to ensure that DPGs are properly maintained over time (Digital Public Goods Alliance, 2022).

Existing financing mechanisms for DPGs are predominantly grant-based, relying on bilateral donors, philanthropic foundations, and multilateral development bank contributions. While these sources have sustained flagship platforms such as DHIS2 and OpenMRS, they introduce dependencies on development finance cycles and donor priorities that may not align with the long-term programmatic needs of the platforms. The G20's 2025 work on global public goods financing acknowledges that financing gaps remain a significant obstacle, and that existing funding modalities need to be optimized to reduce financial fragmentation while maximizing development impact (G20, 2025).

5.3 Data Privacy, Security, and Digital Rights

As DPGs increasingly underpin sensitive functions such as digital identity, health records, and social protection payment systems, concerns about data privacy and security have intensified. High-profile data breach incidents involving identity systems—including reports of tens of millions of Aadhaar records being exposed through database vulnerabilities—illustrate the systemic risks that can arise when large-scale digital infrastructure is not adequately secured (CSIS, 2025). More broadly, the UK Government's 2024 Digital Development Strategy acknowledges that digital public infrastructure can increase the capability for surveillance, decrease privacy, undermine accountability, and exacerbate the exclusion of vulnerable groups if not suitably designed and governed (UK Government, 2024).

The DPGA Standard's requirements for data privacy and security protections represent an important institutional safeguard. However, scholars and practitioners have noted that compliance with these requirements is often assessed through self-reporting by solution developers, raising concerns about the depth and rigor of verification. Furthermore, the adequacy of privacy protections may vary significantly across national regulatory contexts, as data protection laws differ substantially between high-income and low-income countries. Effective DPG deployment therefore requires not merely technical compliance with open standards but active investment in national data governance capacity.

5.4 Digital Inclusion and Equity

A foundational premise of the DPG agenda is that open digital resources can reduce inequities in access to technology and knowledge. Yet evidence from DPG deployments reveals persistent gaps between this aspiration and realized outcomes. DPG adoption requires baseline digital infrastructure—connectivity, devices, and technical capacity—that remains unevenly distributed both between and within countries. The 2023 survey of DPG experts

conducted by CBAS identified infrastructure deficits and capacity constraints as among the most significant barriers to effective DPG implementation for SDG monitoring purposes (Liang et al., 2023).

Gender dimensions of digital exclusion warrant particular attention. Women in low-income countries are statistically 19% less likely than men to access mobile connectivity, creating structural barriers to participation in digitally mediated public goods even when those goods are technically non-excludable (UK Government, 2024). Open licenses and technical openness are necessary but insufficient conditions for equitable access; deliberate inclusion-focused design, localization, and community engagement are equally essential.

5.5 Geopolitical Tensions and International Cooperation

The DPG agenda operates in a geopolitically contested environment in which competition over digital standards, supply chains, and data governance frameworks threatens to fragment the international cooperation on which DPGs depend. Observers have noted that geopolitical competition has demonstrably affected global technology standards—themselves a form of public good—and that the politicization of concepts such as 'human rights' in the context of DPG principles could complicate development cooperation between states with divergent political systems (Oxford Global Society, 2023). These tensions underscore the importance of multilateral forums such as the G20 and the UN in providing inclusive, politically neutral platforms for DPG governance.

6. Emerging Policy Directions and Future Research Priorities

Several emerging trends are reshaping the DPG landscape and opening new avenues for both policy engagement and scholarly inquiry. First, the intersection of DPGs with digital public infrastructure (DPI) has become a dominant policy narrative. The '50-in-5' Campaign, a partnership of foundations, government agencies, and multilateral development banks, aims to develop safe and inclusive DPI in 50 countries within five years, with DPGs serving as key enablers (CSIS, 2025). The 2024 Global DPI Summit, convened under UNDP leadership, gathered stakeholders to shape the technology, policy frameworks, and implementation models required to transform public infrastructure through open digital solutions (UNDP, n.d.).

Second, the relationship between DPGs and climate action has gained significant policy attention. DPGA activities in 2024 included research on DPGs and DPI in Brazil, producing analysis that emphasized how digital public goods can advance Brazil's climate goals and contribute to sustainable development more broadly (Digital Public Goods Alliance, 2024). Youth-focused open-source development events organized by the DPGA in partnership with the UN Office on Reboot the Earth engaged participants from countries including Ethiopia, Mexico, Morocco, and others in building solutions for drought forecasting and disaster resilience—demonstrating the potential for DPG ecosystems to mobilize grassroots innovation for environmental sustainability.

Third, questions of DPG scalability and maturity assessment have attracted growing institutional investment. The DPGA's development of a digital self-assessment tool to measure scalability and readiness, in collaboration with Digital Square at PATH and GitHub, reflects a maturing ecosystem that is moving beyond certification toward supporting the full lifecycle management of DPG solutions (Digital Public Goods Alliance, 2024). This work connects to broader scholarly interest in platform governance and the institutional conditions that enable DPG platforms to evolve generatively over time.

Fourth, the methodology for evaluating DPG impact on SDG outcomes requires further development. The CBAS survey of international experts identified a need for international standards, adherence to open science principles, and stronger coordination mechanisms to ensure that DPGs contribute effectively to data-driven SDG policy (Liang et al., 2023). This gap represents a rich agenda for interdisciplinary research combining information systems, development economics, public policy, and data science.

Fifth, the research literature on DPGs remains nascent and would benefit from diversification of methodological approaches. Nicholson et al. (2022) characterized DPGs as 'a relatively new discourse in the field of ICT4D,' noting that international organizations and donors portray them as key enablers toward the SDGs, yet comparative empirical evidence for this claim remains limited. Longitudinal comparative studies, natural experiments arising from differential DPG adoption, and systematic reviews of implementation outcomes across different institutional and contextual settings are needed to build a more rigorous evidence base.

7. Conclusion

Digital public goods represent one of the more intellectually and practically significant innovations in contemporary development policy. By extending the logic of public goods provision to the digital domain and

institutionalizing openness as a design requirement, the DPG framework creates a mechanism for mobilizing global collaborative intelligence in service of shared developmental objectives. The cases of DHIS2, OpenMRS, MOSIP, and a growing registry of other DPG solutions demonstrate that open digital platforms can achieve remarkable scale, adaptability, and impact when supported by appropriate governance, funding, and technical communities.

Yet the review also reveals substantial challenges. The free-rider problem, governance fragility, data privacy vulnerabilities, persistent digital divides, and geopolitical tensions all constrain the realization of DPGs' developmental potential. Addressing these challenges requires action at multiple levels: international coordination to build inclusive governance frameworks; national policy environments that support local adaptation and maintenance of DPGs; community investment to build the technical and organizational capacity required for sustainable deployment; and research to generate the evidence needed to learn from experience and improve practice.

The 2024 adoption of the Global Digital Compact by UN Member States, with its explicit recognition of DPGs as enablers of SDG progress, marks an important milestone in the institutionalization of this agenda. However, institutional endorsement is only the beginning. Translating the promise of DPGs into tangible improvements in human welfare—particularly for the billions of people still excluded from the digital economy—will require sustained political commitment, innovative financing, inclusive design practices, and rigorous accountability mechanisms. The trajectory of the DPG movement over the coming decade will be a significant test of the international community's capacity for effective collective action in the digital age.

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