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Digital Public Goods for Development: A Conspectus and Research Agenda

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Abstract: Digital public goods (DPGs) for development is a relatively new discourse in the field of information technology for development (ICT4D). DPGs are currently portrayed by international organisations and donors as key enablers towards the accomplishment of the Sustainable Development Goals (SDGs). However, there is a paucity of research that establishes the link between the DPGs and the SDG and examines the contribution of DPGs to development. This paper introduces the DPG discourse and relevant theoretical concepts. We then present a case illustration of the UN-centred discourse on DPGs, showing a technology orientation in the goals and mission statements. Drawing on research on DHIS2, commonly used in the discourse as a prominent example of DPGs, we develop a research agenda related to the methods, theory and philosophy we find appropriate for advancing our understanding of DPGs, the link between DPGs and the SDGs and for development in general.

Keywords: Digital Public Goods, Sustainable Development Goals, DPG, Research Agenda

1. Introduction

The purpose of this paper is to contribute to a relatively new global discourse based on digital public goods (DPGs) as central to ICT for socio-economic development. DPGs are defined as digital technologies and content that “are freely and openly available, with minimal restrictions on how they can be distributed, adapted, and reused” [1: p. 17]. Examples of DPGs can be found across multiple sectors in low and middle-income countries (LMICs), including the electronic medical record OpenMRS¹ the foundational identity system MOSIP², and the health information system DHIS2³. More examples can be found at Digital Square⁴ and the Digital Public Goods Alliance⁵.

More specifically, this paper is motivated by the portrayal of DPGs by international organisations and donors as key enablers towards accomplishing the Sustainable Development Goals (SDG), both directly as contributors to solving concrete challenges, and indirectly as serving as digital building blocks to foster further innovation⁶. It is well recognized that the well-being of citizens relies on the provision of public goods by national governments [2]. The extension of public goods to increase the provision of DPGs secured by international cooperation is also posited by

¹ <https://openmrs.org/>

² <https://www.mosip.io/>

³ <http://dhis2.org>

⁴ <https://digitalsquare.org/>

⁵ <https://digitalpublicgoods.net/>

⁶ See <https://digitalpublicgoods.net/>

some as contributing to the SDGs [3]. SDGs are a collection of 17 global goals designed to be a “blueprint to achieve a better and more sustainable future for all”, which succeeded the Millennium Development Goals. The SDGs were set in 2015 by the United Nations General Assembly and intended to be achieved by the year 2030.

This focus on DPGs in relation to development has already influenced funding opportunities and endorsements via curated lists of DPG principles, and reference implementations that highlight selected DPGs made available for countries and agencies involved in ICT4D (for example [4]). However, we posit that in this nascent stage there is limited empirical data and theoretical knowledge to support the relationship between DPGs and SDGs and how these technologies may facilitate or inhibit development outcomes [5, 3, 6]. There are many examples in the field of ICT4D of technological determinism as a feature of failure such as in the case of the One Laptop per Child (see for example [7]). Indeed, technology and society are intertwined [8], and it becomes paramount for researchers to understand the social, political, institutional and cultural contexts, which shape DPGs and their relations to development [9]. We are thus concerned here with directing a critical focus on DPGs and related initiatives.

Concurrently, initial research on the new discourse of DPGs for development has pointed out numerous challenges and tensions. For example, [3] emphasised the impact of globalisation, which entails growing interconnectedness that increases the number of critical challenges affecting mostly those living in the poorest nations. Indeed, the power asymmetries between groups of people (e.g., gender, geography, resources distribution), along with policy-practice gaps, namely, knowledge, governance, procurement, participation, capacity, and financial gaps - prevent the normative ideal of DPGs to be achieved. Additionally, Nicholson et al. [10] pinpoint the scaling challenges of DPGs through a case analysis identifying paradoxes of DPGs: using sophisticated tools for relatively simple analysis; prioritising voices that tend to be unheard; and building software simultaneously relevant for global and local contexts. Those paradoxes reveal the competing effects with the macro and micro and the impact of collective action and governance to promote DPGs effectively. In the context of these debates, this paper aims to contribute to advance our understanding of DPGs and the SDGs. We do so by developing a research agenda and by focussing on the following research question:

How can DPGs contribute to sustainable development and what are the underlying challenges and opportunities to achieve the SDGs?

The authors of this paper are actively engaged in action research into DPGs in relation to the Health Information Systems Programme (HISP) on the District Health Information System (DHIS2) at the University of Oslo⁷. Our theoretical position is broadly aligned with the social constructionist perspective and that implies viewing human activity in organisations as being context-bound. Thus, there is an emphasis in the work of our group on consideration of the local, emergent and contingent and on understanding how attitudes are shaped by particular historical, political and/or cultural circumstances [12]. Our theoretical position opposes the technological determinist view and we posit that we best understand DPGs as an ideal, a socio-technical accomplishment that is ongoing rather than as embedded into a repository of static and transferrable technological artefacts.

The paper is organised as follows: First, we review prior literature in public goods and DPGs and outline some concepts related to technological determinism. There follows a case illustration of an international organisation that is promoting DPGs - the Digital Public Goods Alliance and our analysis of it. Finally, the paper develops a research agenda to help establish the relationship between DPGs and SDGs.

2. Literature Review and Conceptual Framing

The following section outlines public goods, DPGs and the central tenets of technological determinism.

2.1. Public Goods

The body of research on public goods is extensive, relating back to the ground-breaking work of Samuelson [13] and more recently Nobel laureate Elinor Ostrom on the governance of commons and the fundamental principles of non-rivalry and non-exclusion [14]. One individual’s consumption of public goods does not influence what is available for others and exclusion from consumption is impossible or prohibitively expensive. A well-cited example of a public good is a lighthouse, where one navigator’s use of the light does not reduce availability to other navigators, nor can one effectively charge for use, as exclusion is impossible.

While having individual and societal benefits, a challenge is how to produce adequate levels of public goods in the absence of market mechanisms. In her research, Ostrom showed that under certain conditions individuals can overcome the lack of a functioning market or regulations, to obtain benefits in a sustainable way through collective action. Achieving this on the large scale needed for *global* public goods, available and relevant across groups of people, geographies, and generations [2], adds another level of complexity in terms of design and governance.

Public Goods are goods that members of a group benefit from regardless of whether they contribute towards creating and sustaining them. Public Goods, such as education and healthcare, are acknowledged to promote social change through inclusion and a shared sense of citizenship [15]. A challenge with these goods is that their provision may be

⁷ See for example [11] or <http://dhis2.org>

unreliable due to inadequate incentives to supply them, and the need for government interventions or collective actions. Furthermore, there may be variations due to the nature of services provided which could be public, private or hybrid yielding complexity to the conceptualization [3].

Prior research has demonstrated that public goods provision has a role in the progression towards the SDGs including overcoming poverty, improving health, education, security and protecting the natural environment [16].

2.2. Digital Public Goods

DPGs, like other public goods, are goods that anyone can benefit from, regardless of whether they contribute towards creating or sustaining them. They are in the form of software, data sets, AI models, or content that are generally free and contribute to sustainable national and international digital development. As such, the digital world today offers a large number of public goods globally, thus becoming digital global public goods (DGPBs). Despite the costless nature of accessing DPGs, they are only available to users that have Internet access generating a digital divide between who have and who do not have access to digital infrastructure.

Evidence suggests that digital technologies share characteristics with public goods, however the “digital” has a particular dynamic different from that of the non-digital, for example a lighthouse. Bonina et al. [17] define digital innovation platforms as facilitating the production of content, products or services developed by one or more parties, and serving as the foundation upon which other external actors can effectively build further derivative and complementary innovations. Thus, by following this logic open digital platforms (e.g., open-source software, open data and artificial intelligence models) are considered DPGs by enabling non-rivalrous and non-excludable access. These traits, however, are not the default and not necessarily permanent fixtures as with other types of public goods but because of an ongoing design effort.

For some stakeholders, extending the concept of public good to DPGs is seen as fundamental to attaining the SDGs. For example, the 2021 Sustainable Development Goals Report shows the potential of DPGs related to information access⁸. Another example is in SDG3 (Good Health and Well-Being) where the lack of data is a key obstacle to assessing the impact of Covid-19. DPGs are claimed to address this by promoting a collaborative form of social value creation by distributing system development costs and supporting agility and rapid propagation of innovations by being freely available for all to modify, deploy, and promoting interoperability and other practices including open data [18].

Table 1. Summary of DPGs studies in the ICT4D literature

Authors	Study Method	Main Findings
Sahay, S. (2018) [3]	Case study in the public health sector in India	A core policy issue is ensuring collective action at the global level to facilitate the production of, and access to, goods, and yield significant external benefits, across multiple nations. Two key characteristics have been identified to successful Global Public Goods: (i) design based on principles of platforms and, (ii) a governance strategy that enables platform principles in design and practice. Also, there are six policy-practice gaps that have been identified to move closer to the normative ideal of a GPG, addressed with context-specific strategies.
Nicholson, B., Nielsen, P., Sæbø, J., & Sahay, S. (2019) [33]	Case study of digital platform installed in over 80 countries globally, primarily used in the health sector (DHIS2)	Four tensions have been identified in global public goods based on the case of digital platforms for innovation: (i) between serving those that can pay for functionality and those that cannot, (ii) between DHIS2 as a generic software and an appliance, (iii) between supporting the platform core and supporting innovation in the fringes; (iv) between global and local accountability. The theory of contradictions helps illustrate some of the tensions, confronting simplistic and linear views that implementing GPG health management platforms will translate unproblematically to efficiency gains. Cultivating a GPG mindset in the users as well as platform owners is necessary which may imply a cultural change.
Sæbø, J. I., Nicholson, B., Nielsen, P., & Sahay, S. (2021) [10]	Case study of digital platform installed in over 80 countries globally, primarily used in the health sector (DHIS2)	The potential for translating and contextualizing digital platforms for the purpose of socio-economic development remains understudied. The theory of paradoxes help to capture the dynamics of the Digital Global Public Goods (DGPB) phenomenon as they evolve over time and space to understand their scaling challenge in health. The study identified 3 main paradoxes: (i) using sophisticated tools for relatively simple analysis; (ii) prioritising voices that tend to be unheard; and (iii) building software simultaneously relevant for global and local contexts. Those paradoxes reveal the competing effects with the macro and micro

⁸ <https://unstats.un.org/sdgs/report/2021/>

		and the impact of collective action and governance to promote DGPGs effectively.
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Thus, it is crucial for both the research and practice of ICT4D to understand the nature of DGPs for development. Conceptually understanding the nature of DPGs will potentially contribute to ICT4D discourses, particularly on how the potential of digital technologies can be better materialized for development. There is an emerging, nascent literature in this domain of DPG for development summarised in table 1 above.

2.3. Technological Determinism

The relationship between technology and society can be understood from a technological determinism perspective where technological change determines social changes in an established way [19, 20, 21]. Technological determinism has been considered a controversial theory [22] stating: "... the development of technology proceeds in an autonomous manner, determined by an internal logic independent of social influence" [22: p.15495].

Over the years, technological development and innovation have become an important motor of social, economic or political change [23]. Conversely, evidence suggests that technology is a major cause but not the sole determinant of social change [22]. Scholars rather argue that technological design is the outcome of negotiations between several social groups and between the social and the technical, rather than the product of an internal, technical logic [24]. Despite the criticism, Winner [25] emphasised the relevance of technology's social effect, arguing that determinism should not be rejected as "technology does constrain human activities" [26: p. 77].

Technology determinism can take the form of "an idea, theory or a way of explaining technology development in history or the present, but it can also take the form of actual material structures that—implicitly or explicitly—permeate and influence society" [27]. It is therefore a result of what is societally desirable and what is technically possible. Thus, while DPGs can be an essential enabler for accomplishing the SDGs, we still need to understand their properties, how they relate to other technologies and how they influence and are influenced by the social setting in which they are implemented and used.

3. Case Illustration: The emerging UN-centred discourse on DPGs

We illustrate why a research agenda on DPGs for development is needed by looking at recent developments led by various international collaborations and spearheaded by the United Nations system. Below we track the emergence of a discourse among international agencies that hold significant power of funding and legitimacy in the ICT4D field.

In 2014 the Digital Impact Alliance (DIAL) was formed, culminating more than a decade of work by international development organisations on how to include digital tools in their programming for improved outcomes. DIAL is a community of development agencies, both from the UN system and philanthropist organisations such as the Bill and Melinda Gates Foundation, country development agencies such as SIDA from Sweden and USAID, and various NGOs and companies. A flagship project is the Principles for Digital Development, widely endorsed globally. One of the tenets of these principles is "invest in software as a public good"

In 2018, the UN Secretary-General convened a high-level panel on digital cooperation, which released its report the year after. It noted that DGPs are important for the innovation of inclusive digital products and services, but that there is no 'go-to' place for such DPGs. A clear recommendation was the establishment of "a broad, multi-stakeholder alliance, involving the UN, [to] create a platform for sharing DGPs, engaging talent and pooling data sets, in a manner that respects privacy, in areas related to attaining the SDG" [28: p. 4]. Here DPGs were defined as digital technologies and content that are "freely and openly available, with minimal restrictions on how they can be distributed, adapted and reused" [28: p. 11]. As a strategic response to this call, the Digital Public Goods Alliance (the Alliance) was formed.

The Alliance is a "multi-stakeholder initiative with a mission to accelerate the attainment of the SDGs in LMIC by facilitating the discovery, development, use of, and investment in digital public goods" (<https://digitalpublicgoods.net>, accessed 16.01.2022). Its board includes UNICEF and UNDP, the development agencies of Germany and Norway, and the Government of Sierra Leone. The Alliance has taken the lead in the focus on DPGs over the last few years, as it has developed a standard for DPGs, as well as maintaining a registry of certified DPGs that meet this standard. While the definition of DPGs according to the Alliance has naturally evolved since the early phases, the current one states that they are "... open source software, open data, open AI models, open standards and open content that adhere to privacy and other applicable laws and best practises, do no harm, and help attain the Sustainable Development Goals" [29]. This definition is broad in terms of what manifestation of the digital it includes, but introduces an explicit link to the SDGs, as well as carrying other normative values. The registry the Alliance maintains of DPGs is making it easier for interested parties to discover them, the "to-go" place as the high-level panel on digital cooperation envisioned. For inclusion in this registry, there is a formal application process using the DPG standard, which follows the definition mentioned above.

A few points are noteworthy here. The first is the requirement of documentation of relevance to SDGs. Another is linked to licences, where the Alliance does accept stricter licences when it comes to prohibiting commercial reuse while at the same time encouraging licences allowing for commercial reuse. Lastly, a few well-intentioned aspects are related to data privacy, security, adherence to applicable laws, and last but not least that the projects “have taken steps to ensure the project anticipates, prevents, and does no harm by design”⁹.

DIAL also maintains a list of relevant digital tools. This list explicitly links which SDGs they address, but is not exclusively for DPGs. Some digital tools that are well known in the ICT4D sphere appear in both lists. For instance, the health-related DHIS2 platform is listed in both, as a certified DPG and as relevant for SDG 3 (health and well-being), 4 (quality education), and 17 (partnerships for the goals). Together these lists potentially carry a lot of weight, on the one side linking digital technologies to SDGs, and on the other side functioning as a gatekeeper for what the Alliance considers as “good” technologies.

The DPG standard and curated list are two of the tools the Alliance applies to reach their goals of improving the discoverability, uptake, and sustainability of DPGs in LMICs. In addition, the Alliance takes a proactive role in advancing high impact DPGs by providing funding resources to strengthen DPG ecosystems. A stated aim is to work with governments in LMICs and regional hubs to change the power balance around technology solutions and DPGs are seen as an unprecedented opportunity to achieve this [29].

The Alliance, despite the first impression of being technology-focused, also calls for local ownership and local capacity to fully leverage digital technologies’ innovative potential. This point is echoed by the Lancet and Financial Times Commission on governing health futures 2030: Growing up in a digital world, which argues that DPGs, due to their defining characteristics and associated values of sharing and openness, can play a strong role in enabling domestic ownership and control of digital public infrastructure cultivation [30].

Some challenges with DPGs are recognized by the Alliance. For instance, while digital technologies hold the potential to support development, they may likewise exacerbate inequalities. Further, the Alliance emphasises that the success of DPGs is not only related to its software features but also requires transformations of other systems, structures and practises in the context in which it is implemented.

The rhetoric of DPGs is rapidly permeating other relevant agencies. Digital Square, a ‘marketplace’ for health technology solutions, is funded by a similar set of investors; UNICEF and WHO, national development agencies such as GIZ of Germany, USAID and PEPFAR from USA, and the Swiss Agency for Development and Cooperation, as well as other NGOs like Bill and Melinda Gates Foundation and Rockefeller Foundation. They earlier worked with so-called global goods, defined as “digital health tools that are adaptable to different countries and contexts”¹⁰, but now increasingly link to and refer to DPGs throughout their websites. Indeed, their current material seems confused, caught in the middle of updating their global goods references to DPGs, signalling a shift towards a public goods perspective.

The last organisation we briefly introduce here, though not the only one adopting a DPG rhetoric, is Co-develop, springing out of a convening by the Rockefeller Foundation, the Alliance, and the Norwegian Ministry of Foreign Affairs¹¹. They aim to be a resource mobilisation platform with a focus on Digital Public Infrastructure (DPI), which can be supplied by either proprietary technology or DPGs. It is still in the establishment phase and their material may not be representative of the final destination. While being more agnostic as to what business model is behind the technology, a linear causality from digital technologies to SDGs is implied through quotes on their banners and a 5-step DPI development model.

4. Analysis

The rise of the discourse among the actors described above will inevitably have an influence on the broad field of ICT4D. As funding, legitimacy, and attention are steered towards DPGs, developers of technology, practitioners and implementers alike will be likely to adapt. Many of the same organisations are behind several of the collaborations mentioned above and thus it is not surprising that similar material and rhetoric appear across the related websites. However, we also note that these organisations combined make up a significant power constellation in the field of ICT4D and our short case illustration brings attention to some of the potential pitfalls and current shortcomings of this discourse. Three main points are particularly relevant:

First, DPGs are still poorly understood, as evidenced by the definitions used. Drifting away from the more classical definitions of public goods and global public goods, the SDGs are included, as are other normative values like “do no harm”. This is not necessarily a bad thing as trading some definitional clarity for normative prescription may be very much in the interest of the organisations mentioned. However, we note a lack of clarity and in particular a lack of understanding of the *digital* aspects of DPGs.

⁹ <https://digitalpublicgoods.net/standard/>, accessed 14.01.2022

¹⁰ <https://digitalsquare.org/digital-health-global-goods>, accessed 14.01.2022

¹¹ <https://www.codevelop.fund/aboutfaq>, accessed 14.01.2022

Our contention is that exploring the potential of DPGs to support achieving the SDGs is a worthy goal, however, the design and use of digital technologies are different from other technologies (goods). The basis of DPGs are digital technologies [31] that are reprogrammable and thus multi-purpose, and their architecture is flexible, modular and layered. Digital technologies promote open innovation [32] based on assembling and re-assembling digital components of various kinds over time, allowing for an agile, cyclic and infinite process of design to meet diverging and emerging needs. While sharing many traits with digital technologies, DPGs are also uniquely different, which warrants studying them specifically and critically. For example, DPGs must be usable across multiple contexts and relevant both on a global scale (across different sites and generations) and locally (flexible enough to fulfil local and idiosyncratic needs) to be inclusive [33].

A second point to induce from the case is a tendency towards technological determinism and this takes several forms. The agenda of the DPG Alliance is based on DPGs supporting the achievement of the SDGs. However, this relationship and the mechanisms to release the potential of DPGs for the SDGs remain unexplored. While certain ‘qualities’ of different DPGs can be assessed before it is eventually approved and included in the registry, the effect and value of a DPGs towards the achievement of SDGs can only be realised when it is put into use and used over time. The DPGs will not be implemented in a vacuum, but in a context where use is influenced by existing practises, institutions, other technologies and politics. Whether the DPG will ‘do harm’ or not is not an attribute of the technology alone, but a consequence of how it is implemented and used and may change over time. While the Alliance promotes successful examples (for example DHIS2), there is limited theoretical knowledge about how to design, scale, govern, and use DPGs in practice and how to reduce and not magnify inequalities. Thus, the broad goal of “accessibility for all” to digital tools [29] risks a similar outcome to previous initiatives that were criticised for technological determinism and ultimately failed. The Alliance do acknowledge the need for capacity building, fostering ecosystems of businesses and academia etc., for sustainability. Overall, the discourse is unbalanced; focusing predominantly on the promises of technology while not engaging with the socio-political aspects of making it work, of unintended consequences, and of local appropriation.

Our third point concerns the link between DPGs and the SDGs that relates to the consumption side of the goods, which tends to be implicit, as discussed above. The link between the organisations engaging in the discourse and the production of the technology is at the same time more explicit. Digital Square is set to be a marketplace where technology developers, funders, and implementing agencies can find each other. DPGs are by definition the result of market failures (as are any public goods), and establishing mechanisms to supply them and scale them over time is crucial. The involved organisations are well placed to be the future “international public sector” that provides DPGs.

While DPGs may accelerate the move towards a more inclusive future for all, they can also reinforce and magnify existing inequalities. The growing gender gap in Internet use is one example in this respect (see for example UN 2020). These design and use traits indicate how DPGs are unique and their design requires particular approaches, financing mechanisms and governance structures. There is currently a paucity of knowledge about how to scale, govern, and implement DPGs successfully to reduce and not magnify inequalities. Thus, the link between the DPGs and the accomplishment of the SDGs is by large missing in this discourse.

5. Towards a Research Agenda for Digital Public Goods

In this section, we outline a research agenda on DPGs, we emphasise consideration of the global, local, emergent and contingent related to DPGs and their link to the SDGs. We posit and reaffirm our position that DPGs should be understood as an ideal, a socio-technical accomplishment that is ongoing rather than as embedded into a repository of static and portable technological artefact. We hope that this agenda can support the ICT4D community in developing a stronger empirical basis on DPGs, a better conceptual understanding of DPGs and a clearer link between DPGs and the SDGs.

The substantial work on digital transformation in information systems research has facilitated insight into the characteristics of the ‘digital’ dimension of a DPG mentioned above that extends the relatively static public goods examples of a lighthouse, traffic lights, flood defences etc. Open digital platforms are considered DPGs because they enable non-rivalrous and non-excludable access. At the same time, the flexibility enabled by the digital characteristic means that a DPG status could be more fluctuating and temporary compared with other categories of public goods (e.g. flood defences). To illustrate, an example we encountered involved a software application previously distributed freely in line with DPG principles of non-rivalry, non-excludability. However, a decision was made by the organisation management to monetise the application and access to download it was changed in the space of just a few days via a paywall. Thus, reaching the status of DPG is a result of design and a continuing accomplishment. DPGs can be seen as a particular type of digital technology, and with particular traits and challenges, for example, the supply-side challenges related to funding and sustaining them. This has not been addressed in the digital transformation literature and remains a gap in our knowledge.

In the following sections, we develop key themes that form a proposed research agenda on DPGs. For each theme, we propose a central research question. We are actively engaged in action research into DPGs in relation to the Health Information Systems Programme (HISP) on the District Health Information System (DHIS2) at the University of Oslo.

DHIS2 is commonly used as an archetypical example of DPGs, and we will thus draw on our insights to support the research agenda.

5.1. Global versus Local Relevance

In a previous publication in the IFIP 9.4 W.G. proceedings [33] we used a paradoxes lens to explore tensions of DPGs. A key facet of this analysis related to DHIS2 was that the ‘global’ i.e. a generic public good fulfilling the greatest number of possible implementations over time is in tension with the ‘local’ i.e. fulfilling the current needs of local ministries of health at the ‘fringes’, without overwhelming amounts of functionality that is not required and at the same time enabling innovation from the same ‘fringes’. We argued that instead of focusing on DPGs, the focus should be on Digital Global Public Goods (DGPG) relevant locally and on a global scale. The power of international organisations and donors in shaping the core application was revealed as a major force in defining the roadmap and functionality of the DHIS2 implementations. A knowledge gap remains in the role and realisation of subsidiarity (making decisions on the lowest possible level, see e.g. [2]) in DGPGs when by definition applying capitalist free market mechanisms on the supply side is not the solution. Potentially, much can be learned from the extensive previous work on public goods that has discussed collective action when managing natural resources. How this translates to digital technologies and how to conceptualise and practically realise the relevance of the DPGs locally and globally remains unknown.

RQ: How to develop and sustain the relevance of DPGs related to subsidiarity and collective action, and their relationship?

5.2. Local Capacities and Capacity Building

DPGs have much in common with digital technologies in general when it comes to reach and scale and the marginal cost of reproduction. Digital technologies are different from physical as well as other informational goods in that they are malleable and flexible and may come as half-finished products requiring substantial efforts and thus capacity to set parameters, customise and integrate with other components to make them relevant locally. This is also not a one-time effort but requires continuous updates to accommodate new versions and new functionality as well as maintaining the integration with other systems. It is crucial to understand what capacities in terms of human expertise are needed to implement, scale and maintain DPGs locally over time. This capacity will also depend on the particular DPGs and the local design infrastructure they offer including boundary resources. The capacity requirements for physical infrastructure such as hosting, networks and end-user equipment is another element.

RQ: What are the needs for capacity to support DPGs locally and how to build and retain them in LMIC settings?

5.3. The Economy of DPGs

Public goods are a result of market failures, i.e. market mechanisms will not support their production. DPGs are also a result of market failures but by design. DGPGs such as DHIS2 are funded by donors including aid agencies, global development funds, NGOs and philanthropists. A question is whether this is an efficient and sustainable model over time. For example, there is a risk that donors may change their priorities and end their funding. This eventuality could lead to the demise of the DPG, or change its public good status by introducing a fee-based business model. Other relevant aspects of the economy of DPGs relate to scaling, the cost of free-riders and the value of generativity when the DPG is triggering local innovations (such as locally developed apps distributed on an app store) that are brought back into the DPG and shared among all its users. There is thus a two-way relationship between the DPGs and sustainable development. On the one hand, DPGs can contribute to the SDGs by, for example, enabling government agencies to serve their citizens better in terms of improved health and education services. On the other hand, sustainable development involves expanding, preserving, and maintaining digital public goods.

RQ: What is the particular economy of DPGs and how to achieve sustainable donor-based funding arrangements?

5.4. DPGs and Scaling

In a recent article [34], we analysed the challenges of scaling DPGs using the case of DHIS2. A conclusion of the paper was that public sector DPG implementations in LMICs require alternative conceptualizations to that of commercial digital platforms in the global North. This is because of differences in incentives, institutional context and resource constraints [35, 36]. Gaps remain in our knowledge of scaling and DPGs, the ecosystem supporting DPGs across various settings is highly complex and heterogeneous. Building on the insights of Jacobides et al. [37] from the commercial domain would enable in-depth analysis of the symbiosis and challenges presented by the various supporting actors and networks in a DGPG.

RQ. How may DGPGs effectively scale?

5.5. Understanding and Responding to Digital Global Public ‘Bads’

The costs or ‘public bads’ associated with DPGs are largely neglected by the organisations described in the case illustration. We posit that interventions intended to generate DPGs can, and often do, generate ‘bads’ that are also non-excludable and non-rivalrous and therefore can adversely impact a significant number of people. These ‘bads’ are evident in Zuboff’s [38] criticisms of the major digital platforms relating to surveillance, privacy, and security and Masiero’s [39] exclusion of vulnerable groups in Aadhaar, internet crime, fraud, web viruses, denial of service attacks, hate speech etc. The authors’ prior analysis of DHIS2 also identified a ‘bad’ conceptualised as “Global vs. Local Accountability” [33]. A recurrent theme in country implementations of DHIS2 is to collect data on various user groups, such as key populations and certain diseases (for example sex workers and HIV), or for any social program use which in some jurisdictions is illegal to collect. There have been instances where data is collected on religion and caste, and such data has the potential to be misused in the wrong hands. One starting point may be to link DGP ‘bads’ to governance procedures from the commercial platform literature (see e.g. [40]) but as previously stated, this must take into account the developing country resource-constrained contexts.

RQ: How can public bads be identified, conceptualised and controlled in a DPG?

While our theoretical knowledge about DPGs is scant, the catalogue of DPGs classified by the Alliance are already playing an important role in public health in LMICs, including DHIS2, OpenMRS, MOSIP and DIVOC. Countries have already begun to implement these DPGs, but scaling them up nationally and globally still hinges on unexplored territories of standardisation, interoperability frameworks, sharing models, infrastructure for adaptation, capacity building and international digital cooperation.

There is a substantial body of already existing knowledge related to the design and use of DHIS2 concerning non-rivalrous processes of sharing, information exchange, global collaboration and interaction and spillover effects between organisations, countries and continents. However, this knowledge and related implications for policy and practice primarily relates to DHIS2, health information systems in LMICs and is disseminated primarily within the global health domain. At the same time, there is limited empirical research on other DPGs. Thus, to build a stronger theoretical foundation for understanding DPGs, we also call for empirical research on a range of DPGs beyond the public health domain in LMICs, both on how DPGs are funded and developed and how they are implemented and used and their link with the SDGs.

A central element of the DPG discourse is openness represented by open-source software, open data, open standards etc. The existing literature on *open development* in ICT4D research addresses the potential and the challenges of openness related to socio-economic development (see for example [41]). A central theme in the open development literature is the actual value of openness for development and critical discussions of the real positive and negative impact of open technologies. The research agenda we suggest in this paper relates to openness, but each theme also goes beyond and argues that it is not enough for DPGs to be open to make an impact. We thus question the merits of openness and identify five core areas where more research is needed to understand DPGs as a particular type of digital technology and with certain traits of openness. Our hope is that the research agenda presented here with themes and related research questions can inspire and act as a platform for further research to advance our understanding of DPGs.

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