Center for Global Development

Fast-Tracking Development: A Building Blocks Approach for Digital Public Goods

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INTRODUCTION

The world is undergoing rapid digital transformation changing the way individuals, markets and governments interact and operate. Digital technologies have become part of our everyday lives. We communicate through email, text messages and WhatsApp, connect with others on social media, search for information, listen to music, stream movies, shop online and commute using rideshare services. We pay for these digitally through our bank accounts, credit cards, and increasingly, mobile wallets. Many of the digital tools we use today did not exist a decade ago and some may not survive beyond the next decade. The only constant in the digital world is change, and individuals, businesses, governments, and societies need to adapt quickly to keep up with it.

At the same time, there is a significant proportion of the world's population—often the poorest and the most vulnerable—who do not have access to the digital tools and resources that many of us take for granted. As the world moves to a "digital first" approach to economic activity, it is important to ensure that the digital world is inclusive and equitable, advancing the global development objectives—reducing poverty, increasing human capital, ensuring sustainability and creating opportunities for a better life for all.

Digital transformation is an ongoing societal process, not restricted only to private sector led technological innovations. Governments around the world are moving to harness the power of digital technologies to improve their capacity to serve people. Many public services are now digitized and accessed online—passports, driver licenses, land records, just to name a few. Food stamps are distributed as electronic vouchers; pensions, education stipends and social grants are directly transferred to bank or mobile money accounts. These digital mechanisms and processes have played a vital role to support life and livelihoods during the COVID-19 pandemic. It has also highlighted the urgent need to build digital public goods at scale to address the setbacks to development, accelerate the process of building back from the current shock and prepare for the future.

The scale and scope of digital transformation globally require a strategic approach to maximize the opportunities and reduce the risks that digital technologies bring. The conventional approach is to create specific solutions to specific problems that work in specific contexts only. This has been seen to foster redundancies and complexities that create friction to scale. An alternative approach is to think in terms of "digital building blocks" that can operate at scale and be customized for multiple cases and contexts, offering both economies of scale and scope. Each building block can also form the basis of a "digital public good" that can be used by any entity with the capability to be combined to address specific developmental challenges, such as identity verification, financial inclusion, payments, remote learning, healthcare delivery, and administration of justice, amongst others.

The purpose of this note is to explain the concept of digital building blocks as public goods and how it applies to developmental challenges—poverty, inequality, health, education, public administration, and governance—that span entire populations. While the term "building blocks" has been used in different contexts, we believe that there is a need to have a clearer understanding of its core principles, purpose and potential to help build digital infrastructure through a public goods approach that countries can implement strategically. We illustrate this digital building blocks approach using the example of India's effort to create digital infrastructure, drawing lessons and exploring the potential for a global collaborative effort to support long-term development objectives in an increasingly digital world.

The note does not seek to measure the impact of the digital platforms and applications but presents some illustrative data on usage wherever available. A paper considering impact, for example of biometric ID, digital payments, online learning platforms, digital health stack and other innovations would be part of a future research agenda.

ONE BUILDING BLOCK, TWO COUNTRIES

In early 2021, the Supreme Court of Bangladesh unveiled Amar Vasha, an artificial intelligence and machine learning (AI/ML)-based software that translates court orders and judgements from English to Bangla, the national language. The court was inspired in this move by the Supreme Court of India, which launched its own AI/ML based software, SUVAS, in November 2019. SUVAS translates English court documents into nine official Indian languages, including Bangla. With multiple languages used across the courts in India, SUVAS filled an urgent need of the Indian judicial system and millions of its litigants. While launching SUVAS, the then Chief Justice of India, Sharad A. Bobde, said: "While translating judgements is useful, it pales in comparison to the value added to countless litigants and lawyers whose access to timely justice will no longer be limited by the restraints of language."

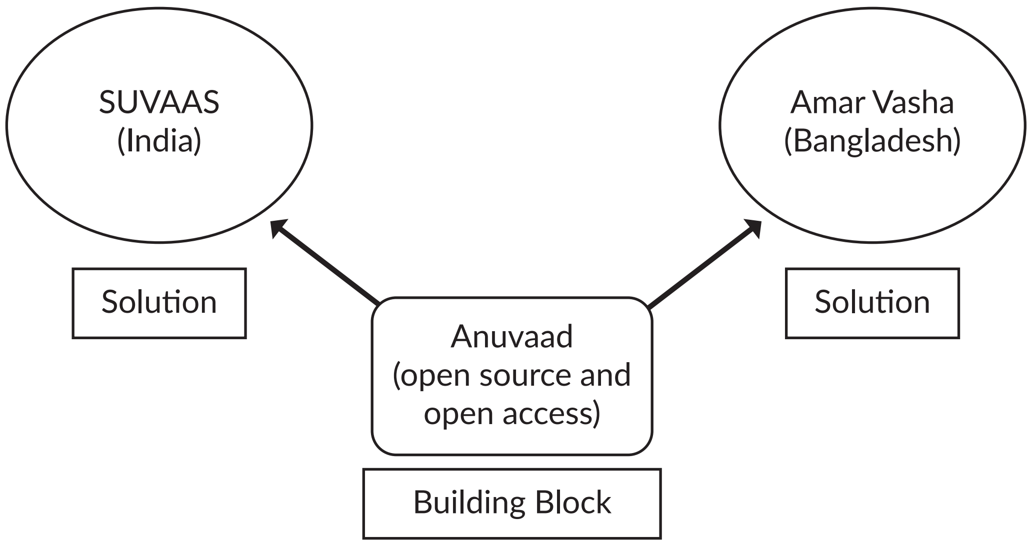
Both Amar Vasha and SUVAS are built on Anuvaad, an open- source, free-to-use AI/ML-based translation engine—a **digital building block** that could be extended to other languages and create solutions in other settings (Figure 1). While it took eight months to design and launch SUVAS in India, Bangladesh was able to launch Amar Vasha in just two months because it benefitted from the evolution of Anuvaad, the building block common to both solutions.

Digital building blocks as public goods

Over the past two decades, digital building blocks have transformed the global economy and society. Building blocks that are in the nature of public goods, such as the Global Positioning System (GPS) and internet protocols, have interacted with market-driven ones such as smartphones, data networks, cloud services, and payment gateways to enable large-scale solutions for e-commerce, transportation, social media, and the gig economy. This catalytic impact of digital public goods is due to their unique characteristics allowing for economies of scale and economies of scope.[1]

1 A pure public good is defined as one that is both non-excludable and non-rivalrous. In practice, there can be some limits on access or sharing. For example, one will need a GPS receiver to access the services of the GPS satellite system but after that service is free.

Figure 1. One digital building block for two solutions



To contextualize digital building blocks as public goods, consider the example of Anuvaad. Anuvaad is a **digital building block** since it interacts with other software through a set of publicly available, or open, standards to create specific solutions such as SUVAS and Amar Vasha. As a building block, Anuvaad could also catalyze translation-based solutions in other sectors such as general administration, education, health, and skills training. This is an example of the type of "plug-and-play" architecture through which digital building blocks can help create solutions across diverse use cases over time.

Anuvaad is also a digital public good since it is free to use by anyone, being open source as well as open access. It therefore fulfills two important characteristics of public goods: they are non-rivalrous and non-excludable. Any country or institution can create its own text translation solution using Anuvaad, while retaining control of both the solution and, more importantly, any underlying data. India and Bangladesh have demonstrated this already. Other potential users could be the United Nations, the European Union, multilateral agencies or humanitarian organizations working across diverse linguistic jurisdictions, both within and across countries.

Digital building blocks may not always be public goods. SUVAS and Amar Vasha can themselves be thought of as building blocks for more complex solutions in the domain of justice. However, neither of them is a public good at present, since they are not open-source or access, though they both are used to improve delivery of public service.

In the next section, we explain the characteristics of digital building blocks, classify them according to their design and function, and relate it to a new approach to address development challenges.

UNDERSTANDING DIGITAL BUILDING BLOCKS

Characteristics and classification of digital building blocks

Put simply, a building block is anything that can be used as a part or component to create something larger or more complex. In the physical world, building blocks are everywhere. They are characterized by three distinguishing features, as illustrated in the example of constructing a house:

1. **They enable us to do something specific in diverse use cases.** Bricks, roof tiles, paint, doors, window frames—each is a type of building block used for a particular purpose, but they can be used in a wide variety of construction projects, from housing to office buildings.

2. **They can be combined for multiple purposes.** Multiple bricks are stacked to create walls of different types and shapes of houses, each plastered and painted as desired by the owner. The same bricks are also used to build boundary walls and other structures.

3. **They compound in value when they are connected or combined for downstream solutions.** The value of a house to the owners is much more than the sum of the bricks, cement, plaster, paint, etc.

Digital building blocks have four important characteristics: they are *autonomous* and *interoperable* and they have *generic capabilities* that *evolve* over time. The GPS—a network of satellites and associated standards initially financed by the US government but now freely available at a global scale—illustrates these characteristics.

- **Autonomous:** Digital building blocks provide a standalone, reusable service or set of services. GPS provides location coordinates autonomously; it solves the question "Where are you?"

- **Generic capabilities:** Digital building blocks are flexible across use cases. GPS location services enable access to a range of digital products like maps, food delivery, taxi aggregators, and even fraud detection.

- **Interoperability:** Digital building blocks combine, connect, and interact with other building blocks through specified communication protocols and interfaces. Application programming interfaces, or APIs, are software intermediaries that allow digital building blocks to talk to each other through published communication protocols. The communication protocols enable a digital exchange of information to use and access services. Interoperability also allows integration with legacy systems in countries and organizations, which is essential for solutions that need to work at scale; for example, a GPS kit can be fitted into a nationwide fleet of delivery trucks.

- **Evolvability:** Digital building blocks are not immune to changes in technology and context. They can be improved even while being used as part of solutions. The camera software can improve during the life of a smartphone without any significant disruption to the user.

There are three ways in which digital building blocks function differently than physical building blocks. First is the **digital exchange of information** that is needed to enable a transaction. Withdrawing cash from an ATM is a physical process but it relies on several digital building blocks whereas paying for goods and services in cash does not.

The second difference is in the **marginal cost structure**. The resources needed for physical blocks increase as the number of copies increases (it costs more to make a million bricks than a hundred). In contrast, the costs of duplicating digital blocks (such as protocols, registries, software, applications, etc.) or achieving economies of scope (expanding the uses of a building block) increase only marginally. For example, suppose an entity—a state, philanthropy, or community of practice—pays for the creation of a building block such as Anuvaad. As in the case of GPS, the digital building block can be converted into a public good and access provided to everyone at little or even no cost with minimal resources needed for maintenance and operation of the building block itself.

The third, related, difference is that a digital building block is **multi-usable** while a physical block can only be used in one application at one time. This makes it easier for the digital building block to serve as a public good, as we explore in the next section, reinforcing its non-excludable and non-rivalrous properties.

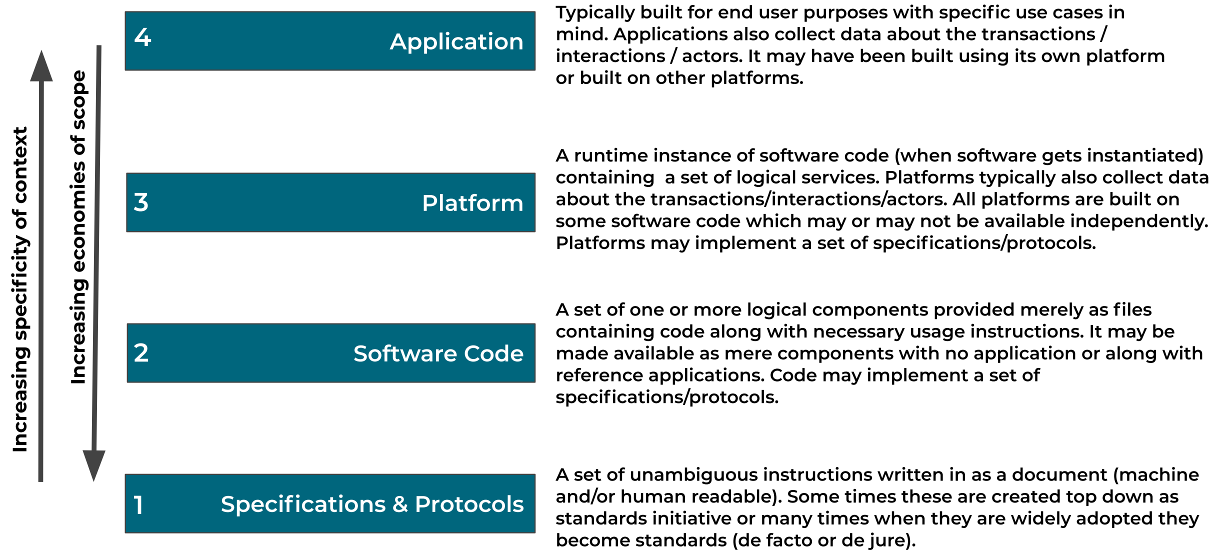
Just as physical building blocks such as bricks and pipes come in various shapes, sizes, and forms, so too do digital building blocks. As long as they satisfy the characteristics above—they are autonomous, interoperable, and have generic capabilities that evolve over time—digital building blocks can be as simple as a document describing a common set of rules for all e-mail programs (Simple Mail Transfer Protocol—SMTP) or as complex as an open-source health information system consisting of hundreds of thousands of lines of code built over two decades (District Health Information Software—DHIS2).

In terms of classification, we identify four types of digital building blocks: (1) standard specifications and protocols, (2) software code, (3) platforms, and (4) applications. They can be either open-source, proprietary, or somewhere in between. Figure 2 sets out these different categories and their associated terminology (the stacked diagram should be read from bottom to top).

This classification can be overlapping and the distinctions need not be rigid. In practice, a building block is easier to identify by its purpose, scope, and use than by its form. Unless prevented by a specific barrier in its design or architecture, a digital building block allows for the freedom to use it together with other building blocks, standards and communication protocols to create more complex, multi-functional solutions. Digital public infrastructure are typically applications or platforms which offer a specific, ready to use service, while digital public goods are typically specifications, protocols and software code which are used to build a service or solution.

It is important to note that applications and platforms (items 3 and 4 in Figure 2) collect data on users and usage, unlike the specifications or code (items 1 and 2) that do not. The collection, storage and use of this data requires clear policies, guidelines, and frameworks to protect personal information. Along with technical standards, it is important to have strong legal and regulatory frameworks governing the use of data to improve development outcomes as an essential complement to the ultimate goal of building digital public infrastructure at scale.

Figure 2. Classification of building blocks



Changing the mindset: From "scale what works" to "what works at scale"

Many countries are working to expand the use of digital technologies to advance development and deliver citizen services. The conventional approach is for countries to pilot a digital transformation solution on a smaller, manageable scale. If the pilot succeeds, the solution is then scaled up to the entire country. This is the **"scale what works"** approach—build one house and then figure out how to replicate it for millions of houses. However, success in the pilot does not assure success of the scale up.

There are two problems with the scale-what-works approach. First, for many real-world development challenges, the movement from test to mass scale has often not worked. Second, by starting with the solution and building it alone, there will be multiple solutions using related elements that will have to be re-created. As an example, suppose there are 10 types of houses and 20 types of industrial plants. Working backwards from every solution will yield innumerable types of brick, doors, etc. that are not necessarily interoperable, leading to waste and a lack of flexibility to shift supply in response to need. For digital, the costs are even higher because the distinctive bricks, doors, etc. all have to be created anew rather than being easily adapted from existing models.

A building block approach to digital transformation reverses this logic. It starts with the universe of houses in mind and asks, "what elements constitute a house?" This unbundling into carefully designed building blocks that work at population scale allows people to design houses that were not even imagined, opening the door to innovative solutions. This is the **"what works at scale"** approach—build the bricks, paint, cement, tiles, etc. and then build a million houses, each of which can be customized as per each owner's unique needs.

Can a building block strategy work for a country's digital transformation? India's experience over the last decade, across sectors like identity, payments, urban governance, health, and education, suggest that "what works at scale" is possible. It illustrates the value of digital building blocks as public goods and offers insights into how this could be replicable in other countries. The next section provides some examples of this approach.

DIGITAL TRANSFORMATION USING BUILDING BLOCKS: EXPERIENCES FROM INDIA

Aadhaar: The transformative impact of a national identity service

Aadhaar—India's initiative to provide biometric-enabled digital identity for all residents—was launched in 2009 and is now almost universal, enrolling nearly 1.3 billion people within a decade. The Unique Identification Authority of India (UIDAI) issues a 12-digit Aadhaar number to an individual who can then authenticate their identity digitally as required. It is a digital building block built for the scale of India and provides a specific service, anytime and anywhere, answering the question, "Is a person who he/she claims to be?"

What sets Aadhaar apart from other national ID systems is its decoupling of identity from entitlement, including citizenship. With an interoperable architecture, it was designed as a building block to be used digitally by other systems (banking, taxation, social protection, etc.) since a legal identification of an individual is a necessary condition to access many public services. With almost the whole population covered, it is now the most widely used ID document in a paper form and is also used to authenticate identity online. This high level of coverage and use was largely because Aadhaar ensured inclusion in its architecture itself—the authentication can happen online or offline, digital or non-digital, whether the beneficiary is poor or illiterate.

Aadhaar provides a building block for many digital applications, both public and private, that require such verification as part of their business process. It was combined with digital payment building blocks like Aadhaar-enabled Payment System (AePS) to create specific solutions to enhance financial inclusion and expand digital payments. As part of federal government's financial inclusion initiative known as the Jan Dhan ('People's Wealth') program launched in 2014, new accounts could be opened by fulfilling Know Your Customer (KYC) requirements electronically through Aadhaar authentication, or e-KYC. These accounts could be linked to mobile numbers, thereby creating the Jan Dhan-Aadhaar-Mobile, or the "JAM Trinity," which comprised three building blocks of legal identity, financial identity, and digital communication. Today more than 80 percent of all Indians have a bank account, up from less than 20 percent in 2008. Using the building blocks approach, India achieved in a decade what would have taken its peers 47 years, based on historical trends.

As Aadhaar was rolled out and bank accounts opened, the Direct Benefit Transfer (DBT) platform was created to digitize government-to-people (G2P) payments, mainly public wages, subsidies, and social assistance. At present, 54 ministries of the government of India use DBT for 320 cash-based social sector schemes reaching 800 million beneficiaries, demonstrating the power of building blocks to provide both economies of scale and scope. This has allowed the government to reach almost half the population with social assistance such as old-age pensions, scholarships, and rehabilitation. It has also helped transform consumer price subsidies on LPG cooking gas into cash payments directly to users, thereby improving the targeting and efficiency of public expenditure. It also played a key role in the rapid transfer of almost $10 billion in social assistance to the poor following the national COVID-19 lockdown in 2020, including to over 200 million women through their Jan Dhan accounts.

As countries consider how best to build foundational ID systems, they face several policy choices, technology options and implementation challenges. As in the case of India, these include ensuring uniqueness in the system, interoperability, privacy by design reaching scale, avoiding vendor lock-in and maintaining affordability. To address these issues—and learning from India's Aadhaar experience—the Modular Open Source Identity Platform (MOSIP) is being developed as a global public good consisting of a set of open-source building blocks that any country can use to create its own national identity management system.

With active interest from Morocco, the Philippines, and Sri Lanka, MOSIP provides a model for global cooperation in building digital infrastructure. As the UN Secretary General's High-Level Panel on Digital Cooperation notes, "there is currently no "go to" place for discovering, engaging with, building, and investing in digital public goods. Along the lines of the MOSIP model—and with the participation of civil society and other stakeholders—such a platform could create great value by enabling the sharing and adaptation of digital technologies and content across countries in a wider range of areas relevant to achieving the SDGs."

India Stack: A combination of building blocks

The interoperable architecture of Aadhaar enabled a combination of different technology building blocks to create a "digital stack" with four layers: identity, payments, documents, and data empowerment. Known as India Stack, it allows governments, businesses, startups, and developers to build on Aadhaar to construct a digital Infrastructure towards presence-less, paperless, and cashless service delivery with user consent. To implement the full suite of these capabilities, two other building blocks needed to be in place:

1. DigiLocker, where digital records move with an individual's digital identity, eliminating the need for collection and storage of large numbers of paper copies; and

2. Unified Payments Interface (UPI), which serves as a single payment interface to all the country's bank accounts and wallets, facilitating access and reducing costs, thereby expanding the digital payments ecosystem for both financial service providers and end-users (explained in detail below).

Aadhaar in India provided a solution for a specific problem (proving who you claim to be). This could have been achieved by only issuing an identity card. However, the building blocks approach has allowed Aadhaar to be combined with other digital blocks to solve other developmental challenges, such as digital payments, as discussed below.

Unified Payments Interface (UPI): Peer-to-peer payment

Moving beyond DBT, another success of India's digital transformation has been Unified Payments Interface (UPI). UPI, launched by the National Payments Corporation of India (NPCI) in 2016, is a peer-to-peer (P2P) payment building block that enables instant sending and receiving of money from a mobile phone through a UPI ID and PIN (personal identification number). The UPI ID can be connected to a verified mobile number and any verified bank account or digital wallet of the customer's choice.

As a building block, UPI protocols supports any form factor (device), any authorization credential (PIN, biometric, etc.), and any stored value account (allowing a mobile money wallet to be interoperable with bank account, for example). UPI is interoperable with banking systems—there are currently 221 participating banks—enabling innovators to create apps that combine multiple banking accounts. There are also 16 third-party apps from global giants like Amazon, Google, WhatsApp, and Samsung, and Indian startups like PhonePe and BharatPe. This provides a level playing field and low barrier to entry for fintech companies and startups to compete for users, reducing the market concentration risk in a digitized financial system.

UPI is just one of the many systems of payment in India; banks maintain their own payment gateways such as IMPS (Immediate Payment Service), RTGS (Real Time Gross Settlement), and NEFT (National Electronic Funds Transfer). Yet like Aadhaar, its characteristics of a digital building block has enabled the private sector to build on top and provide a broad range of financial technology services, transforming the digital payment market in five years. UPI transactions have increased by almost 2.5 times since the start of the COVID-19 pandemic in March 2020 to reach 3.24 billion transactions per month in July 2021, averaging nearly three digital transactions per month for every Indian.

The examples above show individual building blocks which were combined step-by-step for development impact. These building blocks have been built and matured over a decade and their impact has been established at population scale. Below, we illustrate a more evolved **"what works at scale"** approach that uses a suite of building blocks with generic capabilities designed to solve specific challenges to address learning and human development. These are still in early stages to assess impact but already show promise with their scale and usage.

Sunbird: An integrated toolkit of public digital building blocks for education, learning and human development

Acquiring knowledge and skills, both in educational institutions and beyond, is essential for human capital formation and economic development. Taking the building blocks framework, what if the process of learning could be unbundled into a set of interactions around learning, teaching and administration? What if these interactions could be customized by administrators, teachers and students through solutions created from a set of carefully designed digital building blocks working as public goods at population scale? Finally, what if the same building blocks could be reused to create solutions in schooling, higher education, vocational training or professional development and integrated with existing systems—whether they are online or offline, digital or physical—for the end user?

Sunbird performs all these functions. It is a modular, free, and open-source (FOSS) digital infrastructure consisting of a suite of building blocks, as described in table 1. One of those building blocks is Anuvaad, used for translations in the judicial domain across India and Bangladesh.

Sunbird was created in 2017 as a digital public good through a philanthropic initiative by the EkStep Foundation. Currently, the Sunbird community of contributors also has other nonprofits, philanthropic organizations, and for-profits that contribute additional building blocks to Sunbird. Sunbird's building blocks can be downloaded for free and used under the MIT open license by anybody to create customized solutions.

India's school education system is among the largest in the world, and certainly one of the most complex and diverse.[2] Sunbird-based building blocks are being used and configured by the Ministry of Education to build India's national platform for school education, known as Digital Infrastructure for

2 India's education system comprises nearly 1.5 million schools, 250 million students (60 percent of whom study in government schools), close to 10 million teachers, and more than 20 languages as medium of instruction across the 38 states and union territories, with certificates issued by over 60 educational boards.

Knowledge Sharing (DIKSHA). DIKSHA is a versatile, free-to-use school platform with multiple solutions for students, teachers and administrators which include "energized" textbooks that link QR codes to relevant digital content, online courses with digital credentials, assessments, quizzes, chatbots, etc. It is available to the various states and educational boards of the country for use in their respective contexts, as part of the federal structure of education in India. This also means that the states and education boards can use it to best suit their context and can also build on top of the DIKSHA platform in ways that suit their purpose.

Table 1. Selected Sunbird building blocks and their capabilities

Building Block	Capability
Registry	• OpenSABER allows electronic registries to be built up rapidly. • Adopters can incorporate any **kind of registry** (people, entities, things) for specific purposes across any domain. • Provides capabilities for registration, identity, attestation, authentication, discovery, sharing, etc to give the control to the subject in the registry.
Credentialing	• OpenSABER-RC allows rapid implementation of **verifiable credentials** across any domain. • Credentials can be in multiple languages, usable offline, printable with signed QR code, and instantly verifiable.
Knowledge Platform	• Sunbird KP provides content and knowledge management capability for adopters. • Can manage millions of content pieces, use multiple taxonomies, interlink for creation of a knowledge base, tag, search. • Can be organized in a flexible hierarchical fashion.
Learning Platform	• Sunbird LP consists of the core services to manage any user's learning journey. • Micro learning loops can be enabled along with other building blocks for interaction and collaboration. • It leverages other building blocks such as Sunbird KP to allow users to subscribe to learning journeys, monitor the progress, participate in group discussions, take assessments, get credentials etc. across a larger user base.
Assessments	• Project inQuiry provides Question Bank building blocks enabling Sensing in various learning and administrative interactions • It enables a variety of use-cases such as Practice, Quiz, Survey, Assessment—from simple worksheets to be printed for a class, to advanced personalized assessments, or gamified quizzes.
Sourcing	• Capability to engage a wide ecosystem to collect, curate, publish, monitor, and reward the contributions.
Analytics	• The Analytics block provides the ability to measure and observe various actions and activities on Sunbird building blocks. • It also has built-in open data cataloguing and publishing capability. • Telemetry and tools can be adapted to suit specific use-cases.
Translation	• Anuvaad provides translation capabilities for Indic languages (see Figure 1). • While models are being trained for Indic languages, it is built to allow many more non-Indic languages to be brought in for global use.

As stated in the India Digital Education Report, DIKSHA provides autonomy and choice within a national framework. Usage data indicates widespread and intensive use of the platform. It has logged 37 billion minutes of learning from over 3 billion sessions, with over a million teachers accessing curriculum-linked digital content available in 31 languages. In addition, around 3 million teachers have completed close to 7 million courses from over the 2,600 online course options available as part of their continuing professional development, with each of them receiving a verifiable digital certificate.

The multiple building blocks in Sunbird can be mixed and matched to create and customize solutions in accordance with need. DIKSHA's versatility as a platform stems from the way it has leveraged the building blocks available on Sunbird to constantly evolve based on feedback from states, educational boards, teachers, and students.

For example, collating and analyzing student assessments has been a challenge for several years, compounded by the school closures due to COVID-19 pandemic. The Saral Data (or Easy Data) app is a solution created by the Gujarat state government using building blocks of Sunbird which instantly digitizes handwritten assessments. This app is being used by more than 100,000 teachers in the weekly formative assessments called Periodic Assessment Tests (PAT). Data on the learning levels of more than 3 million children across grades 3–8 have been collected through Saral Data. These assessments were conducted even during the COVID-19-related school lockdown as part of continuity of learning efforts of Gujarat. Since it is an open-source solution, other states in India can replicate it and modify it to suit their particular context.

Besides DIKSHA and Saral Data, Sunbird's building blocks have been used to create several other platforms, across sectors:

- iGOT (Integrated Government Online Training) for capacity building of government officials all over the country.
- Shiksha Lokam, a platform to develop leadership across the education system
- Uday, a fintech learning platform by the government of Maharashtra
- NULP (National Urban Learning Platform)

The Sunbird example illustrates the power of economies of scope of digital building blocks as public good—the same set of building blocks creating many platforms, each of which is customized to provide a solution in a specific developmental context. The use of Sunbird extends to the health sector also, as part of DIVOC, the digital certificate for COVID-19 vaccination, as further explained below.

DIVOC: Credentials for proof of COVID-19 vaccination

As governments worldwide increase their COVID-19 vaccination coverage, there is increasing recognition of the need for a verifiable credential of vaccination status ("COVID Vaccine Certificate"). Countries are expected to implement vaccination certificates that can be verified and used by their citizens in both physical and digital form to access jobs, travel, and other opportunities. Several such initiatives are already under way, including the EU-wide Digital COVID Certificate that aims to facilitate the movement of people across borders of its member countries.

It is expected that COVID-19 vaccination will see three phases: vaccine shortage, vaccine adequacy, and eventually, vaccine surplus. A country must be able to use a single digital platform to orchestrate vaccination and certification across these three phases. Investing in a scalable digital health infrastructure is critical to conduct population-scale COVID-19 vaccination and to prepare for and respond to future pandemics.

To address this challenge, the Digital Infrastructure for Vaccination Open Credentialing (DIVOC) was created as a building block to support the digital public infrastructure needed to manage the response to the global pandemic. DIVOC reused Open Saber-RC, the credentialing building block of Sunbird, to digitize the generation of a vaccination certificate available both in electronic form and printable copy downloaded from the central vaccination database.

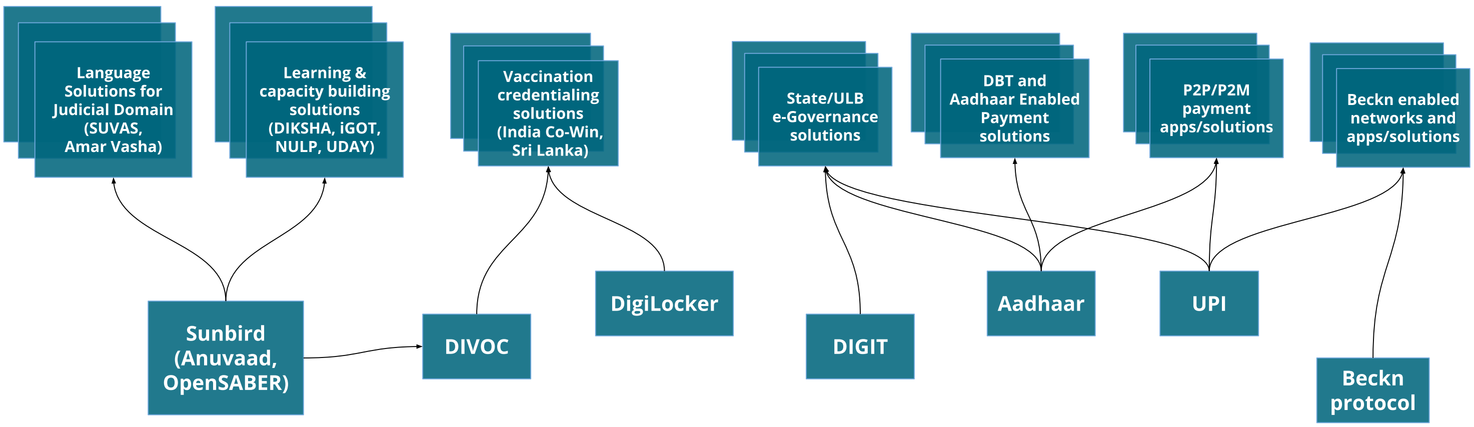
The approach is inclusive by design. It takes into account the diversity in digital access and literacy, where those without the necessary digital tools and skills can acquire the credential in physical locations such as Common Service Centres in rural towns and villages. In addition, DIVOC's vaccinator training and certification module used Sunbird's knowledge platform to support the vaccine rollout, underlining the economies of scope that a digital learning management system can generate in sectors such as health.

In India, DIVOC is the building block for Co-Win, a digital platform for the Government of India's COVID vaccination drive, with over 500 million people receiving at least one dose and verifiable digital credentials issued. The Co-Win platform is owned and operated by the Ministry of Health and Family Welfare which is vested with the authority to collect information necessary to register, administer and certify vaccinations.

With reference to Figure 2, DIVOC as a digital building block (Items 1 and 2—Specification + software code) is different from the Co-Win platform (Item 3—platform instantiated using the software code and specifications) or the application to verify the vaccination certificate online through any camera-enabled computer or smartphone (Item 4). None of these were initially designed as a digital public good. However, with the increasing pace of vaccine rollout, several countries have expressed their intention of customizing DIVOC to their specific needs. In response, the Government of India agreed to make DIVOC open source and provide technical assistance to create customized Co-Win platform as a free and open source digital public good, with over 140 countries attending the global launch of CoWin as a digital public good for the world.

This supports the collaborative effort needed to scale up the global vaccination drive since any country can now use the DIVOC standards and source codes to create their own infrastructure. For example, Sri Lanka is using DIVOC along with the World Health Organization's DHIS2 to create its customized vaccination platform. Guaranteeing that the digital solutions necessary for effectively managing immunization delivery are digital public goods will strengthen cooperation and promote equitable distribution of vaccines across the globe.

Figure 3. Using building blocks for digital public infrastructure



Other examples

Other examples of the building blocks-based public goods include:

- Beckn Protocol, which enables the creation of an open and inclusive network of sellers and buyers, allowing them to execute ecommerce orders over the network. Beckn leverages Aadhaar and UPI building blocks to identify transacting parties and process payments. Beckn was used to recently launch the world's first open mobility network in the city of Kochi, Kerala.

- DIGIT (Digital Infrastructure for Governance, Impact and Transformation), which is a set of digital building blocks around urban governance and service delivery. DIGIT too leveraged Aadhaar and UPI building blocks.

- FASTag, which enables a vehicle driver to make contactless toll payments.

Figure 3 summarizes the use cases described above and sketches their interconnections.

The examples of India's digital public infrastructure highlight the compounding power of the building-blocks approach to addressing development challenges. These leverage the most fundamental feature of the digital ecosystem, namely connectivity. As data and communication networks expand in scope and scale, the building-blocks approach breaks the silos to move from analogue to digital methods of authentication, information exchange, validation and certification, to name a few. The challenge is to appropriately combine the building blocks in a way that improves developmental outcomes, such as through payments, urban governance, learning, financial inclusion, and access to health services.

Not all building blocks are necessary for all contexts; what is needed to address the learning gaps post-COVID is different from what's needed to create a COVID vaccine certificate. But as illustrated in Figure 2, building digital public infrastructure requires an intentional strategy for exploiting building blocks' economies of scale and scope, recognizing that their potential use in some cases may not be evident, or even exist, at present. The objective is to use the set of digital tools at our disposal in a way that compounds their impact, either immediately or over time.

DIGITAL BUILDING BLOCKS AND DEVELOPMENT: THE WAY FORWARD

In most of the cases above, the starting point is not technology—it is a clearly articulated set of policies, strategies, and programs where technology and a digital first thinking is core to the design and architecture. Although this paper focuses on technology, the fundamental strength of the digital building blocks approach is that it is human-centered.

The technology is designed and implemented with the accountability structures, cultural contexts, available resources, and implementation capabilities of the actors in mind. Design starts with unbundling the potential elements of the solution (e.g., identity from entitlement, payment address from payment, credentialing from vaccination) and then creating building blocks for each part of the solution.

This kind of design thinking and architecture also acknowledges the rapidly evolving nature of technology and tries to take advantage of it. It focuses on how technology can help improve human and social capital, both of which are either the end goals or vital milestones to achieve policy objectives.

When seeking to build scalable solutions to development problems, there is a tendency to over-engineer. Beneficiaries are supposed to fit into the mold of what the scalable program requires. Building blocks acknowledge that the complexity of context and conditions are real. Instead of solving the problem, they ask what tools can exist at scale to help the community self-organize to solve their own problems. **The idea is to transfer agency from the top to those who are closer to the problem.**

The COVID-19 pandemic has woefully exposed the shortcomings of a siloed approach to solving developmental issues. The virus has shown no respect for country borders, ministerial jurisdictions, departmental boundaries, and roles of markets and governments. To achieve the Sustainable Development Goals following the disruption of the global pandemic will not be easy.

Addressing global challenges in sectors as diverse as education, health, urbanization, and public administration, digital public infrastructure requires adoption and integration of development technology ("DevTech") into existing social systems, institutions, and accountability mechanisms, as it moves from the familiar to the unfamiliar. Aadhaar, UPI, Sunbird, DIVOC, Co-Win, DIGIT, and Beckn have all been designed as modular building blocks which are digital public goods. Diverse solutions can be built using the building blocks, which dramatically reduces the cost and increases the speed of innovation and the spread of good ideas.

However, a building block approach also requires commitment, perseverance, and support, not only from political establishments within countries but the global development community, including donors, philanthropies, and multilateral institutions. For digital transformation to work towards improving lives, supporting livelihoods, and creating opportunities for progress especially for the poor and marginalized, we stand a better chance when we cooperate and build off each other's progress in the coming years and decades. Digital building blocks allow us to share that progress in a meaningful way. The experiences of Bangladesh, India, and Sri Lanka in Anuvaad and DIVOC show that there is such a path of collaborative progress at scale.

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Ideas to Action: Independent research for global prosperity

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