ICT-Driven Development in India and Africa

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Nirupam Bajpai, Abhishek Beriya, John Biberman, Anchal Sharma, Manisha Wadhwa

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EARTH INSTITUTE | COLUMBIA UNIVERSITY

Abstract

Information and Communications Technology (ICT) has developed into one of the most significant tools at India's disposal for confronting challenges of development and poverty alleviation. In particular, ICT has proven useful when applied to the fields of agriculture, education, health, governance, and urban development. In recent years, numerous African countries have likewise introduced ICT solutions to various development challenges. While these initiatives have made great contributions, African countries interested in improving their ICT for development programs would greatly benefit from strategic and technical cooperation with India. India faces similar development challenges in an environment of high geographical, social, and economic diversity, making it an ideal testbed for developing interventions which scale in the developing world. Programs which have proven themselves in this context could likely be smoothly adopted to the African context, accelerating the pace of development for African ICT solutions. Ideally, India and Africa could cooperate not just on developing individual platforms, but on formulating an ethical and strategic framework for ICT-driven development which encourages inclusion, respects privacy, and shapes both regions to meet the future demands of the global economy.

Introduction

Information and Communications Technology (ICT) has shaped the trajectory of the Indian economy for decades, and for some time, it has also begun to define India's approach to development. As technological advances eliminate barriers to information, slash the cost of sharing data, and accelerate the speed of communication, digital technology will increasingly pave the way for more rapid, inclusive, and environmentally sustainable growth. Likewise, in recent years, Sub-Saharan African economies and societies have demonstrated that they will be next to pick up the baton of ICT-driven development. Africa has been referred to as "the next frontier for the internet,"[1] and as many as 50% of all jobs in some African countries will likely require digital skills by 2030. In fact, with the African population expected to triple by 2050, a digital transformation may be necessary for employment to keep pace with the continent's precipitous growth.

The Government of India (GOI) was keeping this national experience in mind, as well as the needs of developing countries around the world, when it drafted its national ICT for development strategy, including for AI.[2] In these documents, NITI Aayog, GOI's official policy think tank, made public its desire for India to serve as a workshop for incubating the kinds of applied ICT solutions which can resolve persistent challenges in the developing world. India has a vibrant technology industry, which produces many tools which can be applied to development; it has an enormous population and tremendous internal diversity, meaning any ICT tool which broadly succeeds in India would also likely scale up in the rest of the developing world; and it faces the same types of development challenges that other developing countries, particularly in Africa, face.

African countries have already made great progress in developing their own ICT-based solutions to sustainable development challenges, but India has been able to experiment with

[1] https://www.forbes.com/sites/miriamtuerk/2020/06/09/africa-is-the-next-frontier-for-the-internet/?sh=272e485d4900

[2] https://niti.gov.in/writereaddata/files/document_publication/NationalStrategy-for-AI-Discussion-Paper.pdf

ICT for development to such a degree that these countries would benefit from drawing lessons from India's experience. For instance, Indian agriculture applies ICT to improve crop intensity, conserve resources, and build a more efficient national market. ICT platforms for education allow for high-quality pedagogical materials to be shared with all students, regardless of background or location. Digital health tools multiply the reach of doctors in an environment prone to shortages, which has already paid dividends during the COVID-19 pandemic. And ICT platforms can both implicitly build greater inclusion for marginalized groups and explicitly target the needs of these populations. By partnering with private and public Indian institutions alike to implement some of these tools in their own countries, African governments have an opportunity to build the kind of South-South cooperation which will help to inclusively lift their economies to meet the demands of a rapidly changing global economy.

National Identification Systems

India ranks as the second most populous country in the world, with a population of 1.366 billion, and is likely to reach 1.652 billion by 2050.[3] To cover this huge population, multiple overlapping identification systems have been established in India, such as birth certificates, passports, Voter ID, and the PAN Card (income tax identification). However, the presence of these multiple identification systems caused complications to emerge over time. To avoid unnecessary redundancy in personal identification data, in 2016, GOI unified these many separate ID systems under the Aadhaar system, a unique database which allows for both online and offline verification of digital records through the two-factor authentication of a single new ID number, tied to an individual's biometric information.

A universal and flexible digital identification system along the lines of Aadhaar offers multiple advantages over the decentralized, analog maintenance of government records. Digital IDs provide new avenues for individuals to gain economic and non-economic benefits by expanding social and political inclusion, rights protection, and transparency. They also allow individuals to gain increased value and benefit from interactions with firms, governments, and other individuals through mechanisms such as financial inclusion, reduced onboarding costs, and direct benefit transfers. Because digital IDs can be authenticated unambiguously and remotely over digital channels, they could provide a potent tool for providing documentation, and access to critical government and economic services by extension, to the nearly one billion people in the world who continue to lack any form of legal identification. By 2030, this crucial aspect of digital IDs could be responsible for unlocking as much as 6% GDP growth in emerging economies, grounded in expanded opportunities for the most excluded populations within these countries.[4] Therefore, developing a robust national digital ID system should be a top priority for developing countries around the world. The impacts of these systems are so far-reaching that their effects are just now being fully grasped.[5] While implementing these systems, governments must also take care to centralize user agency, prioritize informed consent, and provide deeply embedded safeguards against government misuse, all of which have been stumbling blocks for new digital ID systems in the past. India's experience with Aadhaar, as well as the

[3] World Population Data Sheet, 2013
[4] McKinsey Global Institute, 2019.
[5] Sen S., "A Decade of Aadhaar: Lessons in Implementing a Foundational ID System", ORF Issue Brief No. 292, May 2019, Observer Research Foundation https://www.orfonline.org/research/a-decade-of-aadhaar-lessons-in-implementing-a-foundational-id-system-50464/#_ednref4

experience of countries such as Kenya in the process of implementing their own digital ID systems, provide object lessons in what causes such challenges to emerge and what strategies are useful for overcoming them.

Aadhaar as a Pathway to Inclusion

As mentioned, the Aadhaar database furnishes a 12-digit Unique Identification Number (UID) to every resident of India. The number is randomly generated and actively delinked from the attributes and identity of the applicant. Rather, basic demographic information combined with biometric indicators such as fingerprints, iris scans and facial images are maintained on file to provide verification of the card holder's identity. This approach not only prevents fraud and identity theft, it also avoids fake and ghost identities, since linking numbers to an individual's biometrics makes duplicate IDs impossible. Aadhaar numbers have been issued at this point to 92% of the Indian population, allowing the system to become the foundation of government, business, and society interactions with citizens in a way which no prior UID system had previously been capable of. [6] As the new flagship technology of India's welfare state, Aadhaar can provide portable and near-instant authentication of any beneficiary's identity as well as confirmation that an entitlement has been delivered to said beneficiary. As a result, Aadhaar has made India's governance more inclusive, responsive, and accountable.

Among the many functionalities of the Aadhaar system, building a digital pipeline between users, their mobile numbers, and their bank accounts may prove the most impactful. This pipeline, often referred to as the JAM trinity (Jan Dhan-Aadhaar-Mobile), provides a direct backbone for Direct Benefit Transfer (DBT) flows to other welfare schemes in India. Furthermore, the JAM trinity provides a skeleton for financial inclusion for the unbanked, who had previously struggled to access government benefits with ease and simplicity. Under the *Pradhan Mantri Jan Dhan Yojana* (PMJDY) system, launched in August 2014, 403 million new accounts have been opened for unbanked individuals, 55% of them women. Almost all these accounts were opened using digital verification through Aadhaar. This particular initiative already started to bear fruit during the COVID-19 pandemic, when a total of Rs. 307 billion (4.25 billion USD) in cash relief was deposited in the accounts of female PMJDY account holders between April and June 2020 alone.
Furthermore, about 80 million PMJDY accountholders regularly receive direct benefit transfer (DBT) from the Government under various schemes.[7]

Kenya's National Integrated Identity Management System

Certain African countries have also initiated digital UID systems similar to Aadhaar. Among the leaders in the region is Kenya, which initiated its National Integrated Identity Management System (NIIMS) program in 2019. NIIMS has the stated goal of creating and managing a central master population database which will be the 'single source of truth' on a person's identity. Under NIIMS, every enrolee will be assigned a UID, or a Huduma Namba, and a digital multipurpose ID card, or a Huduma card.[8] Ultimately, the database will contain

[6] 1.288 billion(https://uidai.gov.in/aadhaar_dashboard/) out of a current population of 1.39 billion(https://www.iipsindia.ac.in/)
[7] https://pib.gov.in/
[8] https://www.hudumanamba.go.ke/

information of all Kenyan citizens and foreign nationals residing in Kenya and will serve as a reference point for ease of service delivery to the people of Kenya.

The scale and scope of Huduma Namba registration has been laudable, but the program has to this point experienced certain challenges. Currently, data capture requires applicants to supply a range of existing identity numbers issued by various state agencies, including birth certificate numbers and national identity card numbers. Many residents and Kenyans have been unable to provide this information because they do not hold secure documentation of their identity. Individuals facing this hurdle have not been able to register for the program and have been left in limbo as to their ability to access services and claim rights in the future.[9] Thus, the nearly 38 million registrations which have so far taken place have been dogged by controversy amidst claims that the system would unfairly exclude individuals and violate their rights. These concerns were compounded by the announcement by the Government of Kenya that the existing national ID card would be phased out by December 12, 2021 in favor of the Huduma Namba card.[10] Given that only 70% enrolment has been achieved so far, eliminating existing IDs without taking further steps to securely enroll as many residents as possible by simplifying registration requirements would indeed pose the risk of depriving constituents of access to public services. If this occurs, then Kenya's UID system would end up serving the cause not of inclusion, but of exclusion.

Key Lessons from Implementation of Aadhaar

The fraud and privacy concerns which have driven the strict registration requirements in Kenya's NIIMS program are valid, beyond a doubt. After all, a secure digital identity system has a long-term impact on the critical development of infrastructure, institutions, and access to public services.[11] Robust data protections have been emphasized by the highest courts in both India and Kenya,[12] and India's supreme court even struck down private access to Aadhaar data to strengthen data privacy.[13] At the same time, a balanced approach must be defined to simultaneously promote universal registration, facilitate ease of access and verification for as many types of services as possible, and to avoid excessive deference to ulterior political motives in the public sphere or economic motives by private entities.

The Aadhaar system made inclusion its first priority, and took several steps to ensure that the most excluded populations could be reached while dampening concerns about privacy and government overreach. For instance, the Aadhaar system is linked not to citizenship, but to identity. This expands access to undocumented groups, which have often both been in the most need of government services and the most hesitant to seek them out. For some of these groups, Aadhaar has in fact provided the only pathway to obtaining a legal identity, since an introducer authorized by UIDAI (UID Authority of India) can formally register individuals

[9] Kenya's National Integrated Identity Management System. March 2020. Briefing Paper, Open Society Justice Initiative. Open Society Foundations, New York. https://www.good-id.org/en/articles/kenyas-national-integrated-identity-management-system-briefing-paper/
[10] Kimuyu H., Nairobi News, 2021 https://nairobinews.nation.co.ke/editors-picks/expect-an-sms-if-you-registered-for-huduma-namba-ministry
[11] https://www.usaid.gov/digital-development/digital-id
[12] https://privacyinternational.org/long-read/3373/kenyan-court-ruling-huduma-namba-identity-system-good-bad-and-lessons
[13] https://www.financialexpress.com/industry/aadhaar-dot-stakeholders-to-hold-deliberations-on-customer-verification/1329620/

who otherwise lack any other documentary proof of address or identity. This greatly expands access for the poor and marginalized who otherwise lack the identification documents they need to receive state benefits.

The Aadhaar registration system also prioritized speed and affordability, made possible through a ground-up standards-based approach. Aadhaar registration costs a mere 1.16 USD, which is only possible thanks both to the system's efficiency and the absence of a smart card. The centralization of the Aadhaar system has further streamlined the service. From the beginning, UIDAI incorporated authentication services into the design of Aadhaar, establishing structures and protocols for verification which connected directly to the central ID repository to make the system "digital" in every sense of the word.

For African governments wishing to implement their own digital UID system, or to build upon the example of other systems in the region, a number of lessons can be drawn from these two experiences. First, reaching universal enrolment is paramount to making sure not just that the system is effective, but also that it doesn't ultimately work against its own purpose. To meet this goal while respecting concerns about privacy and data security, governments could follow the example of Aadhaar in linking their UID to biometric identity rather than citizenship, lowering barriers to enrolment and reducing exposure to information vulnerable to theft. The financial burden of registration could also be reduced by eliminating unnecessary physical documentation. Finally, both countries could continue to work towards strengthening their legislative frameworks for privacy safeguards, and would benefit from a joint dialogue concerning best practices for data protection.

Distance and Digital Education

India has been continuously exploring possibilities for bridging education disparities between various regions in the country. The open and distance learning system has potential to remain an option for flexible and affordable quality education. It can provide improved accessibility and showcase novel alternative forms for capacity building. Serious thought is now being put behind optimizing ICT tools and platforms. Therefore, many prominent universities like the Indian Institute of Technology (IIT), Amrita Vishwa Vidyapeetham, and Indira Gandhi Open University (IGNOU) have contributed to the momentum of creating MOOC (Massive Open Online Course) platforms in India from a very early stage. GOI has realised the need for making a unified platform integrating several MOOCs offered by the higher education institutions in the country. In fact, IIT Bombay launched a new digital platform called SWAYAM (Smart Webs of Active Learning for Young Aspiring Minds) in 2017. The motive behind such a move was to improve the Gross Enrolment Ratio (GER) for learning from 20% at present to 30% by 2020.

The e-learning platform is designed to strengthen the three core pillars of education policy, namely access, equity, and quality, by operating through school and vocational centres, under-graduate, post-graduate, engineering, and other professional courses. The integrated platform focuses on secondary and higher education to provide students with affordable courses helping them to enter the skilled labor pool. It also provides training in advanced subjects. Currently, the platform offers around 800 certificate courses in collaboration with major Indian universities, distributed between under-graduate, post-graduate, engineering, law, and other professional programs. The reach of SWAYAM further gets amplified via a

mobile application version and 32 SWAYAM Prabha DTH channels, especially amongst less-digitized regions. To this point, around 203 partner institutions and universities have acted as host institutions offering MOOCs through the SWAYAM platform for various levels starting from basic education to postgraduate programs including engineering and refresher courses. 2745 courses are now available as MOOCs, with around 12.5 million students registered for these courses. Another such national platform, e-Pathshala, provides free digital access to books and learning resources to teachers and parents. The main goal is to remove barriers to access for these materials and to help teachers tailor their instruction to the diverse needs and skill levels of their students. These ICT-driven platforms for distance education have helped India with its struggle to improve the total number of learners enrolled in higher education. The Higher Education GER (18-23 age group) in India for the year 2018-2019 was 26.3%. This was an increase over the previous year and is in line with the increasing trend over the years; in 2014-15, it was only 24.3%.

Africa can draw lessons from India's massive expansion of distance education, which has been used both to provide new means for traditional education and to open new avenues for self-directed continuing education. Evidence shows that only 6% of college-age students are enrolled in higher education in the Sub-Saharan African region, indicating there is a need to invest in strong ICT-based educational platforms to increase skills and learning competencies. Such platforms hold strong potential in Africa, where the skills gap is a huge barrier to employability. In Tanzania, for instance, as many as 41% of firms identify an inadequately skilled workforce as a major constraint to operations. Besides helping to relieve demand-based constraints to higher education by simplifying access, these platforms can also ease supply-based constraints by providing subject matter experts easy access to students in specialized topics across the continent.

Without integrating ICT technologies, delivering specialized education to students in remote areas can be difficult, expensive, and time-consuming. Current trends in Sub-Saharan Africa have shown that online education is gaining momentum despite persistent technological barriers. The rapid spread of smartphones has helped digital learning become a more viable proposition. African initiatives like African Virtual University (AVU) and e-Learn Africa are offering a wide range of higher education courses but still there is a long way to go in providing quality educational resources to all students. ICT-driven distance education programs will ensure recognition of online education on par with traditional physical classroom-based education. Drawing from India's experience, African countries should encourage a bottom-up, location-specific approach to skills development, where the policy framework encourages innovations to meet local needs and local priorities.

DIKSHA (Digital Infrastructure for Knowledge Sharing)

DIKSHA is an ICT platform enabling teachers and students alike to gain ready access to resources for learning.[14]

The DIKSHA platform has emerged as the most established ICT platform for education in India. It is an initiative of the National Council for Education and Training (NCERT) and MHRD (Ministry of Human Resource Development) launched in 2017. DIKSHA is a national platform for all states and central government school education covering grades 1-12. EkStep Foundation functions as the technological backbone of the platform and provides technical support to different states adopting the platform. The platform can be accessed through a web-portal and a mobile application. It provides access to a pool of e-content linked to the curriculum through several use cases and solutions such as QR-coded energized textbooks (ETBs). This helps the learner to learn at their own pace and needs. There are training courses for teachers, quizzes, explanatory videos, and helpful resources to create an engaging learning experience. Currently, the platform supports more than 30 languages and diverse curricula put forth by various educational bodies across India such as NCERT, CBSE, and SCERT.

The New Education Policy of India has laid a clear emphasis on access, capabilities, quality, equity and outcomes. To implement these policies, India has been relying on various digital innovations that can work at a large scale while addressing the country's diversity & complexity. DIKSHA has turned out to be one such platform, integrating ICT into all aspects of education. It incorporates user-developed content, student assessment tools, data collection and analysis, and teacher professional development. Furthermore, the platform provides the functionality to incorporate other platforms as specialized modules within the system, a powerful integrative feature with the potential to consolidate many different platforms in existence under one roof without sacrificing local adaptability or flexibility. The fact that the platform is based on open-source technology makes it available free of charge, expanding accessibility. Additionally, the resources can be used offline, making the platform a particularly suitable choice for areas with poor connectivity. In the short time that has passed since its launch, the platform has proven to be a plug-and-play digital solution which can deliver quality educational content within a range of highly diverse settings. These features of the platform make it a perfect choice for its adaptation within the African context.

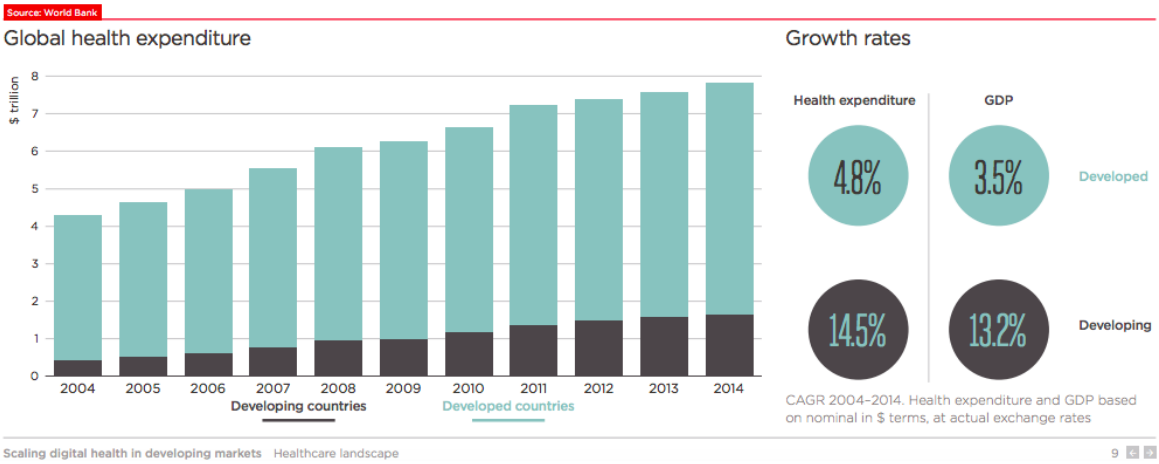
DIKSHA has been playing a crucial role in navigating the challenges faced by the Indian education sector amidst the COVID-19 pandemic. The platform has helped immensely to maintain the continuity of education, leveraging technology to serve teachers and students remotely. The platform accelerated and amplified the scale of the already existing programs and launched multiple new programs specifically in response to the pandemic. Following a well-defined decentralized model of content contribution with review by central and state institutional structures, the platform was able to ensure the quality of these new resources during this challenging time. This method also helped the platform operate and coordinate smoothly with various central and state agencies. With the help of key features like interactive textbooks embedded with QR codes, the platform is helping to bridge the gap between the physical and digital worlds. It has made the process of accessing quality e-content hassle-free as it directly navigates the user to the relevant resources using a smartphone. Following these lessons from DIKSHA's implementation, African countries can benefit from launching a similar platform to combat the many similar educational challenges

[14] https://www.india.gov.in/spotlight/diksha-national-digital-infrastructure-teachers

they face. Such a platform could be a one-stop destination for all educational resources for students, teachers, and parents.

Digital Health and Telemedicine

India and Africa share many commonalities not only in terms of socio-demographic profiles but also with regards to healthcare challenges. India's population is similar to that of the entire continent of Africa, and the majority of Indian states have populations comparable to medium-to-large countries. Indian states also differ greatly from each other on the cultural level as well as the political and administrative level to such a degree that state institutions often operate as though they were ensconced within independent countries.[15] Healthcare is one of these institutions over which Indian states have virtual autonomy over decision-making. Furthermore, both Africa and India face similar healthcare challenges. A high burden of infectious diseases like tuberculosis and HIV/AIDS, emerging epidemics of non-communicable diseases like diabetes and hypertension, rapid urbanisation, shortages of drugs and supplies, a limited healthcare workforce, weak monitoring and evaluation systems, lack of follow-up care, and limited financing mechanisms are all challenges which Indian and African healthcare systems likewise have to face.



In developed and developing countries, expenditures on digital health are increasing as a share of total spending.[16]

India's National Digital Health Mission

Both India and Africa suffer from acute shortage of doctors, especially specialists like radiologists, cardiologists, and paediatricians. Specialists and their services are concentrated in cities, leaving rural areas isolated from their support. In India, around 68% of the population lives in rural areas where there is an acute shortage of doctors and health care

[15] Passi, Ritika, and Ihssane Guennoun. 2018. *Securing the 21st Century Mapping India-Africa Engagement*. Rabat: OCP Policy Center. https://www.orfonline.org/wp-content/uploads/2018/09/GP-ORF-India-Africa.pdf

[16] Data by World Bank, 2014: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2017/07/Scaling_digital_health_in_developing_markets.pdf

specialists.[17] In sub-Saharan Africa, on average, there are fewer than 10 doctors per 100,000 people, and there is not even a single radiologist in 14 countries.[18] In such a situation, telemedicine could play a crucial role in the delivery of healthcare services, particularly specialist services in rural areas.

In November 2019, the Ministry of Health and Family Welfare launched a telemedicine portal, *eSanjeevani Ayushman Bharat-Health & Wellness Centre (AB-HWC)*. This doctor-to-doctor hub soon became a model for implementation of digital medicine in Health and Wellness Centres across the nation. The key features of *eSanjeevani AB-HWC* include Medical Information Systems (MIS), Comprehensive Electronic Medical Records (CEMR), tele-consultation and video-conferencing. *eSanjeevani AB-HWC also* enables real time virtual consultation between patients, doctors, and specialists via video conferencing. At the end of each consultation, *eSanjeevani AB-HWC* generates an e-prescription, which can be used at any pharmacy. Since November 2019, around 240 hubs and more than 5000 spokes have been set in various states and more than 183,000 consultations have been completed.

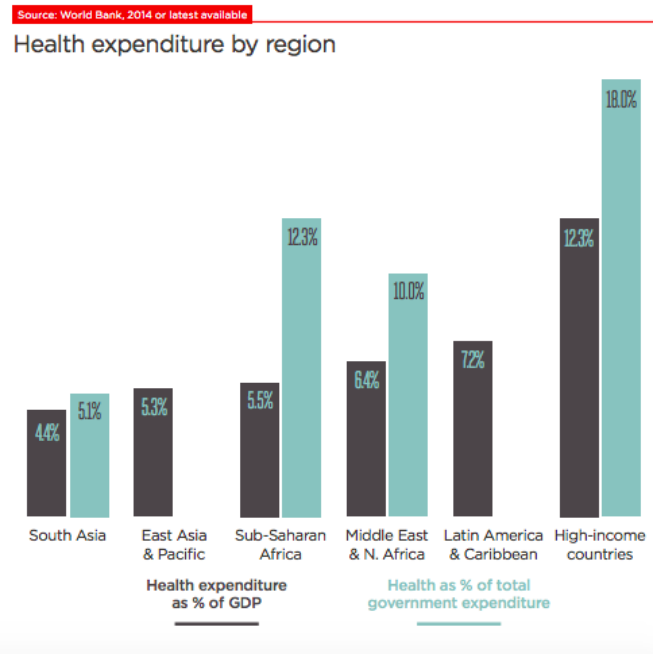
Amidst India's COVID-19 lockdown, the Ministry of Health and Family Welfare launched a national teleconsultation service via a new portal, *eSanjeevani OPD (Outpatient Department)***.** This platform is a doctor-to-patient telemedicine system deployed under the *Ayushman Bharat* Scheme of GOI. A first-of-its-kind online OPD service, it aims to provide healthcare services to people within their own homes. This initiative has been very useful during the COVID-19 pandemic. The main objective of *eSanjeevani* OPD is to provide health advice to individuals with the help of the internet for those who are finding it difficult to visit hospitals due to the pandemic. This service allows people living in even the remotest areas to get a consultation.

Initiatives like *eSanjeevani* could help alleviate acute health care deficiency in regions like Sub-Saharan Africa due to shortages of doctors, especially of specialists. Digital medicine platforms have already been piloted in a variety of contexts in Africa, such as the maternal health portal MomConnect (UNICEF supported), Sierra Leone's Electronic Integrated Disease Surveillance & Response (eIDSR) platform, and more[19]. These multiple, siloed platforms could take the next step toward universality by moving towards integration under a single, comprehensive national digital health platform along the lines of India's National Health Stack. Additionally, the digital health ecosystem requires a stronger legislative framework in order to become sustainable. Finally, remote, rural areas face connectivity issues, as do underserved urban areas. Newly developed eHealth services will need to coordinate with public agencies both to work around infrastructure shortcomings and to develop alternate strategies for including these populations.

[17] Mathur, Pankaj, Shweta Srivastava, Arati Lalchandani, and Jawahar L Mehta. 2017. "Evolving Role of Telemedicine in Health Care Delivery in India." *Primary Health Care Open Access* 07 (01). https://doi.org/10.4172/2167-1079.1000260.

[18] Fraser, H. S F. 2000. "Information Technology and Telemedicine in Sub-Saharan Africa." *BMJ* 321 (7259): 465–66. https://doi.org/10.1136/bmj.321.7259.465.

[19] https://www.bmz.de/en/publications/topics/health/Materilie345_digital_health_africa.pdf



Health expenditure as a percentage of GDP remains persistently lower in lower-income regions.[20]

Digital Agriculture

ICT has revolutionized access to the information which agricultural value chains rely upon. High penetration of smartphones makes for easy gathering of all types of field data, while greater connectivity enables the delivery of real-time information to all types of producers, buyers, and sellers. As ICT continues to penetrate into the agriculture space in India and Africa alike, sellers can look forward to greater profits, consumers can anticipate greater security, and farmers can expect greater access to cutting-edge information than ever before.[21]

[20] Data by World Bank, 2014: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2017/07/Scaling_digital_health_in_developing_markets.pdf
[21] https://www.icrisat.org/digital-agriculture/

Agriculture and ICT. Source: FAO.org

Just as they have in India, digital solutions hold the potential to play a huge role in African agriculture. The agriculture sector in both India and Africa is dominated by smallholders, and rural environments in both regions face similar resource and infrastructure constraints. This means digital solutions which work in India are likely to succeed in Africa as well. Therefore, the agriculture sector across Africa has a great opportunity to greatly boost productivity and well-being simply by adopting best ICT practices which have emerged from the Indian experience.

The 2019 Digitalisation of African Agriculture Report notes that agricultural transformation remains one of Africa's most pressing priorities. Furthermore, Binswanger-Mkhize (2009), in "Challenges and Opportunities for African Agriculture", identifies four main challenges in the African agriculture sector. First, intra-regional trade barriers must be reduced for food and other agricultural commodities to improve cross-border market integration. Second, all aspects of domestic markets must be improved so that farmers gain access to better services and can find stronger markets for their products. Third, rural financial services, especially financing for input markets, must be improved in order to create the conditions for greater farmer profits and improved rural well-being. And finally, African farming must be made more resilient to climate change, which is likely to have a disproportionately negative impact on the region. Indian agriculture has faced all four of these challenges, and has used ICT to varying degrees to begin resolving them.

Digital agriculture solutions require access to a wide range of data to be successful, namely to deliver effective solutions to the 73 million agricultural households and 250 million smallholder farmers and pastoralists across the African continent. ICT-powered business models can accelerate Africa's sustainable agricultural transformation, but only if they remain inclusive of marginalized groups, women and economically vulnerable subsistence farmers. Likewise, there remains an urgent need for the "missing middle" of Africa's digital infrastructure to be financed in order to reach these groups.[22] India can offer examples from a similar context of how each of these challenges can be confronted.

India's e-NAM (Electronic National Agriculture Market)

India's National Agriculture Market (eNAM) is one of the digital agriculture initiatives with the greatest relevance to Africa's agricultural situation. eNAM is a pan-India electronic trading portal which links existing physical marketplaces (APMC mandis, discrete physical market yards managed by the Agriculture Produce Marketing Committee under the purview of the relevant state government) to create a unified national market for agricultural commodities. Implemented by the Small Farmers Agribusiness Consortium (SFAC) under GOI, the digital eNAM platform primarily aims to improve competition and address issues arising from the agriculture market inefficiencies which arise from regulatory differences between different Indian states. Its main goal is to promote uniformity in the agriculture market by streamlining procedures between markets integrated into the platform, removing information asymmetry between buyers and sellers and promoting real-time price discovery based on actual demand and supply. It seeks to achieve this by integrating APMCs across the

[22] Binswanger-Mkhize, 2009.

country into a common online market platform to facilitate pan-India trade in agricultural commodities, providing better price discovery through a transparent auction process based on quality of produce along with timely online payment.

As of December 2020, more than 16 million farmers, 240,000 traders and commission agents, and 1000 mandis (markets) from 21 Indian states have registered on the eNAM Dashboard. The farmers and sellers operating on the eNAM platform benefit from improved, more transparent price discovery, thanks to heightened access to a greater number of markets and buyers. The market will soon be extended to a thousand more mandis for a total of 2000 markets featured on the platform, accounting for almost a third of all agriculture APMC markets in India.[23]

In the near future, the eNAM platform will grow more sophisticated by adopting several useful new features. These include digital registration of farmers and traders; web and phone-based apps, available in 12 regional languages; GPS enabled mandi locator; an online trading portal for out-of-market buyers; electronic warehouse receipts; real-time bid and price tracking; direct trading from co-op premises; quality certifications; digital produce weighting; and a logistics module for inter-state and inter-market transportation.[24]

ICT for Marginalized Communities

Gender inequality is a multifaceted issue in India. Girls face a significant disadvantage in terms of education, nutrition, and socio-familial environment, while women experience a reduced labor force participation rate, a substantial gender earnings gap, and a high rate of domestic violence.[25] These challenges are particularly predominant in rural areas, but remain salient in urban areas as well. For rural and urban areas alike, ICT has proved a particularly powerful tool for promoting gender inclusion in India, following strategies which African countries interested in using ICT to encourage gender equality could adopt as well.

In rural areas in India, The Self-Employed Women's Association (SEWA) organization has been working since 1984 to empower the women it partners with. SEWA has leveraged ICT through, for instance, the distribution of digital videos on social media, providing informative programs which help promote the socio-economic well-being of women[26]. Similarly, the Datamation Foundation has made use of ICT to sensitize people against the practice of female feticide.[27] Tamil Nadu's Foundation of Occupation Development (FOOD) runs an initiative which promotes the direct marketing of products from female micro-entrepreneurs through an inter-city cell phone network, offering participating individuals expanded opportunities for income and independence. Similar initiatives integrating ICT with existing community-based women's organizations (CBOs) could do a great deal to close the gender disparities in income, health, and education which persist in Sub-Saharan Africa.

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[23] Data and information sourced from eNAM official website www.enam.gov.in
[24] eNAM official website; e-NAM: Darbari N., Financial Express, Feb 2021
[25] Mishra, Garima, and Kiran, U,V. "Role Of ICT In Achieving Complete Gender Equality In India" 3 (3): 7; 2015.
https://www.ijtra.com/view/role-of-ict-in-achieving-complete-gender-equality-in-india.pdf
[26] http://videosewa.org/aboutus.htm#top
[27] https://www.andrew.cmu.edu/course/94-812/public/ICT_and_Gender_Equality.pdf

In 1998, the M S Swaminathan Research Foundation (MSSRF) launched the Village Knowledge Centres programme in Puducherry with the aim of adapting tools such as mobile phones and social media to empower marginalised segments of the community, following the established Information Village model. The project evolved into a campaign known as "Mission 2007: Every Village a Knowledge Centre," which aimed to expand ICT access to 600,000 villages across the country. After a massive campaign, the mission evolved into a mass movement called 'Grameen Gyan Abhiyan,' or the Rural Knowledge Network. This multi-stakeholder alliance advocates for the use of ICT to empower rural communities via the establishment of rural knowledge centres. Currently, the use of Artificial Intelligence and Machine Learning tools is being explored under the programme to improve the efficiency of inputs at the farm level (M S Swaminathan Research Foundation (MSSRF), 2019). In Sub-Saharan Africa, where a large share of the population resides in rural areas with limited access to human capital opportunities, an initiative such as Grameen Gyan Abhiyan which provides for the distributed production and dissemination of such knowledge and skills could bear substantial fruit.

Lessons from smart cities in India

Approximately one-third of India's population resides in cities, and it is predicted that 40% of the nation's population will reside in urban areas by the year 2030.[28] As more and more people migrate to urban areas, improving infrastructure and quality of life in these areas will become increasingly important. In 2015, GOI launched the Smart Cities Mission[29], which conceptualised cities which would drive economic growth and improve quality of life by harnessing technology to accelerate local development,[30] primarily using "ICTs and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, and environmental aspects."

As per the mission, the 100 cities included in the initial phase of the program would direct investments toward robust IT connectivity and digitalization, environmental sustainability, e-governance and citizen participation, reliable power and water infrastructure, sanitation, waste management, efficient urban mobility and public transport, affordable housing, and health and education.[31] Key smart ICT infrastructure would include Smart Energy Management Systems, which can provide up-to-date information to make intelligent modifications to improve building energy efficiency, reduce wastage and make optimum usage of water; smart waste management systems that can monitor and control the movement of different kinds of waste; smart healthcare such as telemedicine; smart transport management systems that can reduce the overall need for transportation and travel by offering virtual alternatives to physical movements; and smart education platforms which can inclusively reach children and adults of all social and economic classes.

Sub-Saharan Africa is one of the world's fastest urbanizing regions, and it is predicted that the urban share of the African population will break 50% by 2030. Thus, ensuring these

[28] National Informatics Centre (NIC), Ministry of Electronics & Information Technology; GOI, 2016; Ministry of Housing and Urban Affairs, GOI 2021; Wikipedia, 2021)
[29] National Informatics Centre (NIC), Ministry of Electronics & Information Technology; GOI, 2016.)
[30] Ministry of Housing and Urban Affairs; GOI, 2021)
[31] National Informatics Centre (NIC), Ministry of Electronics & Information Technology; GOI, 2016)

urban environments provide a high quality of life and feature sustainable infrastructure will be indispensable for realizing the overall cause of sustainable development. African policymakers have already drawn up the blueprints for the development of smart cities in the region, and lessons from India's Smart Cities Mission can help refine the implementation of these plans.

Digital finance for financial inclusion of rural areas and marginalised groups

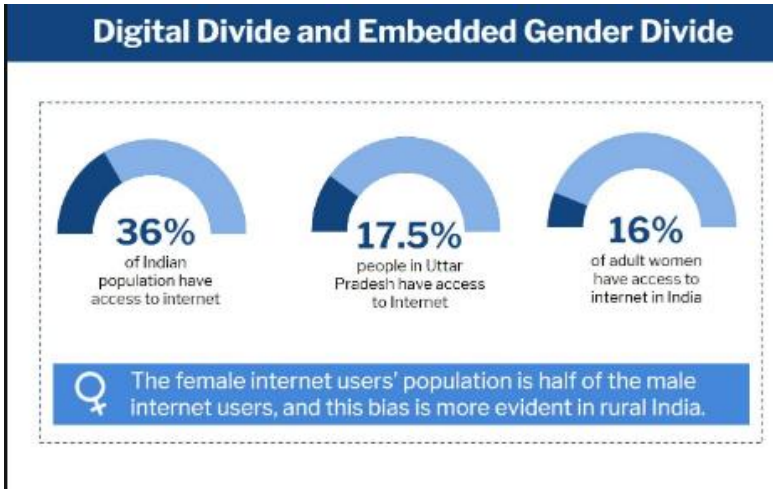
The Government of India has introduced a number of initiatives to promote the adoption of digital financial services, such as Pradhan Mantri Gramin Digital Saksharta Abhiyaan (PMGDisha) andAadhar Enabled Payment System (AEPS). PMGDisha was launched under the Digital India program to boost the digital and financial literacy of the rural population. This scheme empowers citizens in rural areas by training them to operate computers or use digital devices such as tablets and smart phones to browse the internet, search for information, send and receive e-mails, access government services or make digital payments. The program aims to bridge the digital divide by specifically targeting marginalized segments of the rural population, particularly Scheduled Castes (SCs)/Scheduled Tribes (STs), minorities, women, differently-abled persons, and those below the poverty line.

AEPS is a bank-led model which allows online interoperable digital financial transactions at points of sale with any bank using the Aadhaar authentication. The system empowers bank customers to use Aadhaar as their identity to access an Aadhaar enabled bank account and perform basic banking transactions like balance enquiry, cash deposit, cash withdrawal, and remittances through a Business Correspondent. This is likely to substantially boost financial inclusion for the subset of excluded rural customers who lack more traditional forms of documentation. As similar digital solutions to financial inclusion gain a foothold in Africa, particularly those interacting with digital UID systems, rural areas with limited infrastructure will experience strides in financial well-being and market functionality. These two initiatives, among others, offer examples of the types of challenges and opportunities such rural financial inclusion programs feature, and African governments would benefit from reviewing the causes of both their successes and their shortcomings.

Conclusion: Laying the Groundwork for the Digital Economy

The many ICT-based initiatives outlined in the above sections have made significant contributions to growth and inclusion across India's highly diverse society, geography, and demography. In a context such as Africa, where similar levels of economic and social diversity are predominant in addition to similar institutional fragmentation, demographic trends, and sustainable development challenges, implementing initiatives similar to these would also likely do wonders for building robust and sustainable societies. However, certain preconditions must be met, in India and Africa alike, in order for these initiatives to succeed to the fullest possible extent. Major investments must be made in order to narrow the "hard" digital divide between rural and urban ICT infrastructure, as well as between wealthy urban areas and peripheral informal settlements. Similarly, substantial investments in education and human capital must be made to narrow the "soft" digital divide between those with the knowledge and skills to participate in the digital economy and those who are likely to be left out in the cold. Finally, a comprehensive regulatory framework should be elaborated for both regions to govern the challenges and contradictions which will emerge over the course of a

transition to a digital economy, as well as to define the values according to which ICT-driven development policy will strive to operate.



Bridging the digital divide. Source: thewire.in

The digital divide refers to the gap in usage and access to digital infrastructure and services between individuals, households, businesses, and geographical areas. Factors like gender, physical disability, physical access, age, and lack of ICT skills contribute to the digital divide, which has remained stubbornly wide for emerging economies. More specifically, the digital divide is a concern for certain population segments, such as low-income and rural communities, which lack access to affordable digital infrastructure and opportunities to build skills. An African digital revolution would work wonders for economic growth and job creation; the World Bank[32] estimates that just meeting the African Union's goal of universal and affordable internet coverage would cause an increase in GDP growth across the continent by two percentage points per year. In addition to contributing to this growth, digital technologies would transform key sectors of the economy for many African countries, provided the hard infrastructure deficit can be resolved first.

Africa as a whole is still lagging on the digital front, with internet penetration in 2019 averaging 39.6% compared to 62.7% in the rest of the world. Moreover, internet quality and affordability are also very low compared to the rest of the world, and a World Bank action plan for achieving broadband access across Africa comes with an estimated 100 billion USD price tag.[33] India has gained experience from making similar investments in narrowing its digital divide which could help serve as a proof of concept to African countries for how to meet these infrastructure needs under difficult budgetary constraints. For instance, various initiatives have been undertaken by the Digital India program, such as BharatNet, to provide broadband access to local governing bodies, to Smart Cities, and to rural areas via digital post offices and the mobile network. These initiatives have increased the availability of digital infrastructure in remote locations, creating awareness of the benefits of digital services and providing incentives for greater participation from private players and start-ups. Continuing to invest in better internet access will eventually boost start-ups and entrepreneurial pursuits,

[32] https://openknowledge.worldbank.org/handle/10986/31499
[33] https://www.worldbank.org/en/news/press-release/2019/10/17/achieving-broadband-access-for-all-in-africa-comes-with-a-100-billion-price-tag

which will help the citizens of African countries build the technological skills they need to succeed in a global digital economy.

Simple infrastructure investments won't deliver a digital economy on their own. According to the Digital Skills in Sub-Saharan Africa report, 230 million jobs on the continent will require digital skills by 2030. However, currently, only 50% of African countries feature computer skills as part of their core school curricula, compared to 85% of countries globally. Indian digital literacy programs such as the National Digital Literacy Mission[34] and the Pradhan Mantri Gramin Digital Saksharta Abhiyan[35] have reached impressive scales while helping the citizens of the country to grapple with this new, essential skillset. In addition, the Information and Technology Act of 2000[36] was a key contributor to the success of Indian e-commerce and e-governance, and educational platforms like e-Pathshala[37] and DIKSHA[38] have helped provide quality study materials for every rural and urban student while building digital literacy. Closing the soft digital divide has become essential not just for access to services or information, but also for access to basic rights and entitlements. As the digital revolution presses forward, the need for digital skills will become ever more pressing in Africa, and governments can look to India's successes in promoting digital literacy among the general populace to consider what types of interventions will be met with success.

Finally, national policies and regulations surrounding the digital economy should not only promote digitization, but also ensure its co-evolution and complementarity with a variety of other country-specific factors[39]. The Indian government has identified six such critical sectors[40]: 1) banking, financial services, and insurance, 2) transport 3) telecommunications, 4) power and energy, 5) governance and, 6) strategic and public enterprises. The government focuses its enforcement activities on these most vulnerable and high-impact sectors now. Such graded and risk-based approaches can be beneficial in the African context as well, instead of using a one-size-fits-all approach.

The African Union has already undertaken significant work to develop a series of binding norms and regulations around the digital economy, namely through PRIDA, its joint initiative with the European Union and the International Telecommunication Union.[41] The African continent's greatest needs with regards to digitization are building the capacity of member states in the digital space and meeting the demand for hard and soft digital infrastructure. PRIDA pursues this by creating a more harmonized legal and regulatory framework for the use of ICT as a tool for social and economic development, with an emphasis on boosting new digital markets across Africa. By encouraging efficient and harmonized spectrum utilization, aligning measurable ICT and telecommunications policies, and making African decision-makers active participants in the global internet governance debate, PRIDA is helping to ensure that Africa's digital development proceeds in alignment with imperatives of

[34] https://nasscomfoundation.org/national-digital-literacy-mission/
[35] https://www.pmgdisha.in/

[36] https://www.meity.gov.in/content/information-technology-act-2000
[37] https://epathshala.nic.in/
[38] https://diksha.gov.in/
[39] https://link.springer.com/chapter/10.1007/978-981-13-9996-1_1
[40] https://www.orfonline.org/research/a-new-framework-for-a-secure-digital-india/#_ednref24
[41] https://oneprida.africa/digital-platform/

sustainable development. The "Digital India" program has involved a fundamental review of ICT for development policies in India along the same lines, facing similar challenges and opportunities. Moving forward, the AU would benefit from dialogue with GOI to understand the different ways in which their regulatory frameworks pursue the same values of a digital, open society, as well as whether they can be improved in tandem to place inclusion and economic well-being at the forefront of their institutional design.

References

Open Society Foundations. "Kenya's National Integrated Identity Management System". *Briefing Paper, Open Society Justice Initiative.*,New York; March, 2020. https://www.good-id.org/en/articles/kenyas-national-integrated-identity-management-system-briefing-paper/

Ramnath N.S. and Assisi C. "The Aadhaar Effect: Why the world's largest identity project matters". Oxford University Press; 2018. https://www.india.oup.com/product/the-aadhaar-effect-9780199487615

Huduma Namba official website- https://www.hudumanamba.go.ke
https://www.hudumanamba.go.ke/faqs/
Press Information Bureau, Govt. of India.
https://pib.gov.in/PressReleseDetail.aspx?PRID=1649091

Unique Identification Authority of India official website.
https://uidai.gov.in/

Sen S. "A Decade of Aadhaar: Lessons in Implementing a Foundational ID System", *ORF Issue Brief No. 292*, Observer Research Foundation; May, 2019
https://www.orfonline.org/research/a-decade-of-aadhaar-lessons-in-implementing-a-foundational-id-system-50464/#_ednref4

Kimuyu H. Nairobi News, 2021
https://nairobinews.nation.co.ke/editors-picks/expect-an-sms-if-you-registered-for-huduma-namba-ministry

White O., and Madgavkar A., et al,. "Digital Identification: A Key to Inclusive Growth". *McKinsey Global Institute. McKinsey & Company*; April 2019.
https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/digital-identification-a-key-to-inclusive-growth

Dwivedi, G.K and Shruti. "Distance Education and ICT". Academia; 2017.
https://www.academia.edu/37616725/DISTANCE_EDUCATION_AND_ICT

Mondal, Chandra, Gourish and Majumdar Palash. "Impact of SWAYAM towards Academic Achievement". IJ RAR; June2019
https://www.researchgate.net/publication/333868372_IMPACT_OF_'SWAYAM'_TOWARDS_ACADEMIC_ACHIEVEMENT

Patra, Suparn. "Course Report: SWAYAM + NPTEL courses List". *A Report by Class Central*; December 15, 2020
https://www.classcentral.com/report/swayam-moocs-course-list/

Banga, Karishma. "Digital Transformation in Africa: three lessons from India's experience". *Overseas Development Institute*; July 26, 2018.
https://www.odi.org/blogs/10666-digital-transformation-africa-three-lessons-indias-experience

Bajpai, Nirupam., Biberman, John and Sharma, Anchal. "Information and Communications Technology in the Education Sector in India" ICT India Working Paper#3. CSD.Columbia University; January, 2019.
https://csd.columbia.edu/sites/default/files/content/docs/ICT%20India/Papers/ICT_India_Working_Paper_3.pdf

Bhardwaj, Karuna. "MOOCs: A potential solution for challenges in Indian Higher Education". *Research Gate*; July 2019
https://www.researchgate.net/publication/340005602_MOOCs_A_potential_solution_for_challenges_in_Indian_Higher_Education

Kancharla, Bharath. "Gross Enrolment Ratio (GER) of Higher Education improves, but challenges remain". *Factly*; October 22, 2019
https://factly.in/gross-enrolment-ratio-ger-of-higher-education-improves-but-challenges-remain%EF%BB%BF/

Gloy, Robert. "MOOCs: The challenge of Africa". *Technologist.eu*; November 5, 2010
https://www.technologist.eu/moocs-the-challenging-move-into-africa/

African Virtual University. ."AVU Releases Hundreds of New Open Educational Resources". Press Release
https://www.oerafrica.org/sites/default/files/Press%20release%20-%20AVU%20released%20Hundreds%20of%20%20New%20Open%20Educational%20Resources.pdf

Kigotho, Wachira. "Africa must learn higher education lessons from India". *University World News*; April 8, 2016.
https://www.universityworldnews.com/post.php?story=20160408131556282

"Close skills gaps to prepare Africa's Workforce for tomorrow's jobs". *World Economic Forum*; May 3, 2017.
https://www.weforum.org/press/2017/05/close-skills-gaps-to-prepare-africa-s-workforce-for-tomorrow-s-jobs/

India Education Diary Bureau Admin. "16,99,931 School Heads and Teachers have been trained under NISHTHA in 2019-20: Education Minister". *India EducationDiary* ; September 14, 2020.
https://indiaeducationdiary.in/1699931-school-heads-and-teachers-have-been-trained-under-nishtha-in-2019-20-education-minister/

"Over 16.9 lakh school head and teachers trained under NISHTHA in 2109-2020". Education Ministry
http://www.businessworld.in/article/Over-16-9-lakh-school-heads-and-teachers-trained-under-NISHTHA-in-2019-20-Education-Ministry/14-09-2020-320470/

"What is the effect of technology training for teachers on Student Achievement?". *The Reflective Educator*; December 9, 2020.https://davidwees.com/content/what-effect-technology-training-teachers-student-achievement/

"Quick guide: ICT in education initiatives in Africa". *InfoDev*. https://www.infodev.org/articles/quick-guide-ict-education-initiatives-africa

"Unleashing potential in Sub-Saharan Africa". *Unleash.org*. https://unleash.org/solutions/unleashing-potential-sub-saharan-africa/

Nhando, Danai."3 key challenges of Implementing e Learning in Africa". *eLearning Industry*; October 30, 2015. https://elearningindustry.com/3-key-challenges-implementing-elearning-in-africa

Thakrar, Jayshree and Zinn, Denise. "Harnessing Open Educational Resources to the Challenges of Teacher Education in Sub- Saharan Africa". *IRRODL*; September, 2009. http://www.irrodl.org/index.php/irrodl/article/view/705/1319

Millar, Erin. "Africa: TESSA- Using technology for teacher training". *University World News*; November 27, 2011. https://www.universityworldnews.com/post.php?story=20111125211700484

"DIKSHA – Learning from India Experience". Ministry of Education; December 18, 2020.https://www.education.gov.in/sites/upload_files/mhrd/files/Secretary_DoSEL_Presentation_World_Bank_Webinar.pdf

Burgess, Philip I., Gerald, Msukwa, and Nicholas ,Beare AV. "Diabetic Retinopathy in Sub-Saharan Africa: Meeting the Challenges of an Emerging Epidemic." *BMC Medicine* 11 (1); 2013. https://doi.org/10.1186/1741-7015-11-157.

Cory, Nigel and Philip Stevens. 2020. "Building a Global Framework for Digital Health Services in the Era of COVID-19." 2020. https://itif.org/publications/2020/05/26/building-global-framework-digital-health-services-era-covid-19.

Fraser, H. S F. "Information Technology and Telemedicine in Sub-Saharan Africa." *BMJ* 321 (7259): 465–66; 2000. https://doi.org/10.1136/bmj.321.7259.465.

Global Development Incubator. "The State of Digital Health 2019: Global Digital Health Index". 2019 https://static1.squarespace.com/static/5ace2d0c5cfd792078a05e5f/t/5d4dcb80a9b3640001183a34/1565379490219/State+of+Digital+Health+2019.pdf.

Gul, Afsha. "E Sanjeevani OPD: Patient Registration, Esanjeevaniopd.in Appointment." 2021. https://pmmodiyojana.in/e-sanjeevani-opd/.

"Explained: What Is National Digital Health Mission and How It Will Benefit People." *Hindustan Times*. 2020. https://www.hindustantimes.com/india-news/explained-what-is-national-digital-health-mission-and-how-it-will-benefit-people/story-qOKlv3rbkrvB0aR9ZQyvdK.html.

Mathur, Nandita. "Digital Health Technology Can Revolutionise Healthcare in India: Report." 2019. https://www.livemint.com/news/india/digital-health-technology-can-revolutionise-healthcare-in-india-report-1566457450376.html.

Mathur, Pankaj., Srivastava, Shweta ., Lalchandani, Arati and Mehta, Jawahar L. "Evolving Role of Telemedicine in Health Care Delivery in India." *Primary Health Care Open Access* 07 (01); 2017. https://doi.org/10.4172/2167-1079.1000260.

Ministry of Electronics & Information Technology. "E-Sanjeevani." Government of India. 2021 https://www.cdac.in/index.aspx?id=hi_pr_eSanjeevani.

Ministry of Health & Family Welfare. "National Digital Health Blueprint Report Comments Invited." Government of India; 2019 https://www.nhp.gov.in/NHPfiles/National_Digital_Health_Blueprint_Report_comments_invited.pdf.

."Health Ministry's Telemedicine Service e Sanjeevani Completes 9 Lakh Consultations". Press Release; 2020. https://pib.gov.in/PressReleasePage.aspx?PRID=1677674.

Passi, Ritika and Ihssane, Guennoun. "Securing the 21st Century Mapping India-Africa Engagement". *Rabat: OCP Policy Center*; 2018 https://www.orfonline.org/wp-content/uploads/2018/09/GP-ORF-India-Africa.pdf

Philips. "Future Health Index 2019: Transforming Healthcare Experiences - Exploring the Impact of Digital Health Technology on Healthcare Professionals and Patients." 2019. https://www.ehidc.org/sites/default/files/resources/files/Philips_Future_Health_Index_2019_report_transforming_healthcare_experiences.pdf.

Press Information Bureau, "The Prime Minister Shri Narendra Modi Addressed the Nation from the Ramparts of the Red Fort on the 74th Independence Day [Press Release]." Government of India. 2020. https://pib.gov.in/PressReleasePage.aspx?PRID=1646044.

Stallworthy, Guy., Hannah, Monica Dias and Pai, Madhukar. "Quality of Tuberculosis Care in the Private Health Sector." *Journal of Clinical Tuberculosis and Other Mycobacterial Diseases* 20 (August): 100171; 2020. https://doi.org/10.1016/j.jctube.2020.100171.

Vijayan, Shibu. "Finding the Missing Millions: The Importance of Private Sector Engagement for Eliminating Tuberculosis." 2019. https://www.path.org/articles/finding-missing-millions-importance-private-sector-engagement-eliminating-tuberculosis/.

Wild, S., Roglic, G., Green, A., Sicree, R., and Kin, H. "Global Prevalence of Diabetes: Estimates for the Year 2000 and Projections for 2030." *Diabetes Care* 27 (5): 1047–53; 2004.

https://doi.org/10.2337/diacare.27.5.1047.

World Health Organization. 2020. "Global Tuberculosis Report." https://apps.who.int/iris/bitstream/handle/10665/336069/9789240013131-eng.pdf.

Totapally S., and Tsan M. et al. "The Digitalisation of African Agriculture Report 2018-2019. *The Technical Centre for Agricultural and Rural Cooperation (CTA*) Copyright CTA 2019 EU Financing. June, 2019.
https://ergos.in/
https://www.ksndmc.org/

"PM Modi launches Swamitva Yojana to boost rural economy: Here's all you need to know". *Hindustan Times*, April 24 2020.
https://www.hindustantimes.com/india-news/what-is-swamitva-yojana-launched-by-pm-narendra-modi-all-you-need-to-know/story-UpshkST02eW59ZGsF9jxLK.html

"Telangana: Government to decide which crop to be grown in each district under regulated farming policy." *The Economic Times*, May 22, 2020 available at https://government.economictimes.indiatimes.com/news/policy/telangana-government-to-decide-which-crop-to-be-grown-in-each-district-under-regulated-farming-policy/75889636

"Telangana to regulate farming." *Telangana Today;* May 13, 2020 .https://telanganatoday.com/telangana-to-regulate-farming
https://pmkisan.gov.in/
https://enam.gov.in/

Darbari, N. "eNAM:A new paradigm for Agri-trade." *Financial Express*; February 5, 2021 https://www.financialexpress.com/opinion/e-nam-a-new-paradigm-for-agri-trade/2188157/

Arora, Sumit.. "National Urban Digital Mission Launched by Centre." 2021. https://currentaffairs.adda247.com/national-urban-digital-mission-launched-by-centre/

Ashiagbor, David. "Taking Stock of Financial Inclusion in SSA," 12; 2017. https://www.eib.org/attachments/general/events/africa_day_2017_roundtable_proceedings.pdf

Association for Progressive Communications (APC). "A Case Study of the Grameen Gyan Abhiyan Rural Knowledge Centre Movement." 2018 https://www.apc.org/sites/default/files/APCProPoorKit_Advocacy_CaseStudy_MSSRF_EN_2.pdf

Begum Mohammed, Farzana. "An Overview of Digital Financial Services in India: Concept, Initiatives and Advantages." *Asian Journal of Management* 9 (3): 1139–44; 2018. http://www.indianjournals.com/ijor.aspx?target=ijor:ajm&volume=9&issue=3&article=021

Fan, Shenggen and Ousmane Badiane. "Rurbanomics: The Path to Rural Revitalization in Africa." 2019
https://www.ifpri.org/blog/rurbanomics-path-rural-revitalization-africa.

ITC Limited. "E-Choupal." 2021
https://www.itcportal.com/businesses/agri-business/e-choupal.aspx
"ITC's e-Chaupal Ecosystem-Making Agriculture Profitable & Empowering 4 Million Farmers across 10 States" . 2021
https://www.itcportal.com/sustainability/echoupal-ecosystem.aspx

"ITU-T, Smart Sustainable Cities at a Glance." *ITU Academy*. 2021.
https://www.itu.int/en/ITU-T/ssc/Pages/info-ssc.aspx

M S Swaminathan Research Foundation (MSSRF). "Grameen Gyan Abhiyan for Bridging the Knowledge Divide." 2019. https://www.mssrf.org/mssrfthirtyyearsnew/graeem-gyan-abhiyan-for-bridging-the-knowledge-divide/

Ministry of Electronics & Information Technology. "About Digital India." 2021.
https://www.digitalindia.gov.in/

Ministry of Housing and Urban Affairs. "Smart Cities Mission." Government of India. 2021.
http://smartcities.gov.in/

Mishra, Garima, and Kiran, U,V. "Role Of ICT In Achieving Complete Gender Equality In India" 3 (3): 7; 2015.
https://www.ijtra.com/view/role-of-ict-in-achieving-complete-gender-equality-in-india.pdf

National Informatics Centre (NIC), Ministry of Electronics & Information Technology, Government of India. 2016. "Smart Cities Mission: A Step towards Smart India." 2016.
https://www.india.gov.in/spotlight/smart-cities-mission-step-towards-smart-india

Smart Africa. "Smart Sustainable Cities: A Blueprint for Africa." 2017.
https://smartnet.niua.org/sites/default/files/resources/smart_africa_sustainable-cities_a_blueprint_for_africa.pdf.pdf

Telecommunication Engineering Centre. "ICT Deployment and Strategies for India's Smart Cities : A Curtain Raiser." Technical Report 1.0; 2015.
https://smartnet.niua.org/sites/default/files/resources/ICT%20deployment%20and%20strategies%20for%20%20Smart%20Cities.pdf

The World Bank. "Urban Population (% of Total Population) - Sub-Saharan Africa." 2018.
https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=ZG

Tripathi, Shailaja. "Government Launches National Urban Digital Mission." 2021.
https://www.jagranjosh.com/current-affairs/government-launches-national-urban-digital-mission-1614245058-1

World Bank Group. 2018. "Rural Population (% of Total Population) -Sub-Saharan Africa." 2018.
https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=ZG

"Digital Economy for Africa Initiative." 2019

http://pubdocs.worldbank.org/en/312571561424182864/062519-digital-economy-from-africa-initiative-Tim-Kelly.pdf

Songwe, Vera. "The Role of Digitalization in the Decade of Action for Africa." *United Nations Conference on Trade and Development*; September 7, 2020. https://unctad.org/news/role-digitalization-decade-action-africa

Policy and Regulation Initiative for Digital Africa (PRIDA). The Africa-EU Partnership https://africa-eu-partnership.org/en/projects/policy-and-regulation-initiative-digital-africa-prida

Muhoro, Gloria. "Towards an inclusive digital economy in Africa." *Observer Research Foundation*; July 4, 2019. https://www.orfonline.org/expert-speak/towards-inclusive-digital-economy-africa-52730/

"Digital technologies provide fertile ground for Africa." *UNCTAD*; April 16, 2018. https://unctad.org/news/digital-technologies-provide-fertile-ground-africa-eu-says

"Policy Harmonisation." *African Union* https://oneprida.africa/policy-harmonisation/

Ghanem, Hafez. "Shooting for the moon: An agenda to bridge Africa's digital divide." *Brookings*; February 7, 2020. https://www.brookings.edu/blog/africa-in-focus/2020/02/07/shooting-for-the-moon-an-agenda-to-bridge-africas-digital-divide/

"Digital divide in India". *Digital India Initiatives*; July 31, 2020. https://www.civilsdaily.com/news/covid-19-lockdown-highlights-indias-digital-divide/

"Policy and Regulation Initiative for Digital Africa." *European Union*; May 29, 2019.https://www.itu.int/en/ITU-D/Regional-Presence/Africa/Documents/PRIDA2019/Speaking%20points%20Amb%20Jan%20Sadek.pdf

Maiti Dibyendu, Castellacci Fulvio, Melchior Arne. "Digitalisation and Development: Issues for India and Beyond." *Springer Link*; December 4, 2019. https://link.springer.com/chapter/10.1007/978-981-13-9996-1_1

Srivastave, Sumeysh. "International Literacy Day: Bridging India's Digital Divide". *Bloomberg*; September 8, 2020. https://www.bloombergquint.com/technology/international-literacy-day-bridging-indias-digital-divide

Digital India. "Unlocking the Trillion Dollar Opportunity*." Deloitte*; November, 2016. https://www2.deloitte.com/content/dam/Deloitte/in/Documents/technology-media-telecommunications/in-tmt-digital-india-unlock-opportunity-noexp.pdf