ITU Publications

International Telecommunication Union
Development Sector

Build back better with broadband

Research stories from the front line

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Acknowledgements

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We are grateful to the global five-member jury that selected the 15 winners of the Connect2Recover Research Competition. The jury was led by Mr Ahmad Reza Sharafat, Professor of Electrical and Computer Engineering at Tarbiat Modares University, Islamic Republic of Iran. Other members of the jury include Ms Ellen Helsper, Professor of Digital Inequalities at the Department of Media and Communications at the London School of Economics and Political Science, United Kingdom; Ms Ida Nganga, Regional Head of Anglophone Countries of the United Nations Educational, Scientific and Cultural Organization (UNESCO) Emerging Technologies for Development Steering Committee, based in Bordeaux, France; and from ITU, Mr Cosmas Zavazava, Chief of Partnerships for Digital Development Department, and Ms Nur Sulyna Abdullah, Chief of Digital Knowledge Hub.

Finally, we would also like to gratefully acknowledge the efforts undertaken by the 15 research teams. The research stories, insights and recommendations from their 15 research reports have been compiled in this publication.

Disclaimers

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ITU foreword

It is my pleasure to present to you this publication, "Build back better with broadband: Research stories from the front line".

The United Nations Secretary-General's Roadmap for Digital Cooperation states that "meaningful participation in today's digital age requires a high-speed broadband connection to the Internet", and that every person should have "safe and affordable access to the Internet by 2030, including meaningful use of digitally enabled services". As part of efforts to achieve these goals, ITU launched the Connect2Recover initiative in September 2020, to help countries transition from responding to the coronavirus disease (COVID-19) pandemic and natural hazards to building back better with broadband. The initiative has the strong support of Australia, Japan, Lithuania and Saudi Arabia.

As part of the Connect2Recover initiative, a research competition was launched in July 2021 to identify promising research proposals from across the world to accelerate digital inclusion during recovery from the COVID-19 pandemic. This resulted in the selection of 15 winning research proposals in December 2021.

The 15 research teams, which represent 43 universities and institutions from 22 countries, focused on the themes of digital inclusion (in the areas of education, health care, enterprises and job creation, and vulnerable groups), and digital connectivity and resilience. The wealth of knowledge and insights compiled within are based on diverse methodologies, including desktop research, surveys, interviews and focus groups, which covered 17 countries in Africa, the Americas, Arab States and Asia-Pacific.

The research showed that, while the use of broadband and digital technologies has been critical for coping with the pandemic, many people faced challenges and barriers in their adoption and use. In schools and universities, teachers and students struggled to get access to online education. During lockdowns, many in rural communities were isolated from health-care providers in cities. In the business sector, the financial needs of micro, small and medium-sized enterprises (MSMEs) were not adequately addressed by financial institutions. The digital needs of vulnerable groups – such as women and girls, ageing populations and persons with disabilities – were also not adequately addressed.

Nevertheless, there is a silver lining. Barriers faced during the pandemic can be addressed by putting in place resilient digital infrastructure and achieving meaningful connectivity. Ubiquitous and reliable network infrastructure, as well as affordable and accessible services, are essential to deliver digital solutions such as telemedicine, e-education and e-business services.

Policy and regulatory enablers are also critical. Outdated policies or regulations that are not inclusive or do not meet post-pandemic recovery requirements need to be revamped. Digital skills gaps need to be addressed through sustained efforts for institutional and human capacity building. For instance, teachers, health-care providers and enterprises require digital skills and competencies to thrive and be successful; digital literacy is important for everyone, including vulnerable groups, so that they can fully participate in digital societies and economies.

An estimated 2.7 billion people – or one-third of the world's population – remain unconnected to the Internet in 2022. The goal of universal and meaningful connectivity cannot be addressed through improving coverage alone. By leveraging the lessons learned from these 15 published research reports – and working to ensure access, adoption, affordability and resiliency of broadband services – together we can build back better with broadband.

Doreen Bogdan-Martin
BDT Director
International Telecommunication Union

Huawei foreword

Connecting the unconnected means leaving no one behind in the great journey of digital transformation. With 2.7 billion people still not online, we must increase our efforts to provide meaningful connectivity and offer everyone the chance to benefit from the opportunities the Internet brings. Recent years have underlined more than ever just how essential digital connectivity can be.

Against this backdrop, I am proud that Huawei has committed to offering 15 research grants for projects seeking to identify new ways to foster digital inclusion in the wake of the pandemic. This booklet summarizes the results of all these projects. They cover a wide range of countries and circumstances. All of them provide clear policy recommendations rooted in scientific evidence.

Among other results, the researchers outline how digitalization contributes to education, employment, engagement and empowerment. More importantly, they highlight where the roadblocks are to achieving meaningful connectivity for everyone.

The recommendations fall into three categories. First, we need to step up our efforts to understand the precise nature of the remaining digital gaps. Otherwise, we will not be able to bridge them. We can learn from measures taken during the pandemic which have accelerated digitalization all around the world. Second, we require innovative solutions for network roll-out in those areas where it is most needed. This also means taking seriously the role that mobile access plays in many parts of the global South. Third, we must find targeted ways to tackle the specific challenges in local communities. These include schemes to teach online skills and incentivize local content creation.

The time to act is now, and Huawei seeks to make the most of the insights gained by the research projects. We intend to turn selected recommendations into reality by working with policy-makers and our customers, suppliers and partners.

I would like to express my sincere gratitude to all the researchers as well as the excellent team at ITU led by Mr Alex Wong, Mr Sameer Sharma, Ms Karen Woo and Mr Chuluunbat Tsendsuren, under the guidance of Ms Doreen Bogdan-Martin.

Jeff Wang
Senior Vice President
President of Public Affairs and Communications Department
Huawei

Abbreviations

AFRALTI	African Advanced Level Telecommunications Institute
BDT	ITU Telecommunication Development Bureau
COMESA	Common Market for Eastern and Southern Africa
CWN	community wireless network
DM	diabetes
DSA	dynamic spectrum access
GHS	Ghana Health Service
HTN	hypertension
ICT	information and communication technology
IDP	internally displaced person
IoT	Internet of Things
ISP	Internet service provider
ITU	International Telecommunication Union
ITU-D	ITU Development Sector
LMS	learning management system
MSMEs	micro, small and medium-sized enterprises
NGO	non-governmental organization
NIB	network-in-a-box
SIDS	Small Island Developing States
UN-Habitat	United Nations Human Settlements Programme
VSAT	very small aperture terminal

Research competition: The journey, research stories, lessons learned and the opportunity

The journey

The story of the Research Competition began in early 2021 with discussions between ITU and Huawei to design the concept, modalities and desired outcomes within the scope of the Connect2Recover initiative. Connect2Recover aims to build back better with broadband by reinforcing digital infrastructure and digital ecosystems of beneficiary countries, so that they can better leverage information and communication technologies (ICTs) to support COVID-19 pandemic recovery efforts and preparedness for a post-COVID-19 normal, and to remain resilient in hazardous times. In that light, the Connect2Recover Research Competition was designed with the objective to identify promising research proposals that could provide empirically sound and targeted insights, as well as recommendations for fostering digital inclusion during the global COVID-19 recovery.

The Research Competition was launched in July 2021 to encourage research in the area of digital resiliency and digital inclusion to build back from COVID-19 with broadband. When the Research Competition closed in September 2021, there were 307 research proposals received from 80 countries, demonstrating overwhelming support and interest in this area.

The evaluation and selection of the 15 winning research proposals were carried out by a global five-member jury led by Mr Ahmad Reza Sharafat, Professor of Electrical and Computer Engineering at Tarbiat Modares University, Islamic Republic of Iran. Other members of the jury include Ms Ellen Helsper, Professor of Digital Inequalities at the Department of Media and Communications at the London School of Economics and Political Science, United Kingdom; Ms Ida Nganga, Regional Head of Anglophone Countries of UNESCO Emerging Technologies for Development Steering Committee, based in Bordeaux, France; and from ITU, Mr Cosmas Zavazava, Chief of Partnerships for the Digital Development Department and Ms Nur Sulyna Abdullah, Chief of Digital Knowledge Hub.

The 15 winning research proposals were selected in December 2021.[1] Three virtual information sessions were organized in April and May 2021 to introduce the work to the stakeholders, foster synergies and support to carry out the work, enhance collaboration between the teams, as well as build human and institutional capacity.[2] The information sessions were well attended, with a total of 197 participants.

Extensive work has been done by the 15 teams to carry out their research, including tireless and continuous reiterations and reviews of the 15 research reports. The reports will be launched at the event "Best Practices and Recommendations for Digital Inclusion through Resilient Infrastructure" on 28 November 2022.[3] Figure 1 provides the key highlights of the journey.

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1 ITU, Connect2Recover Research Competition – Winning Projects Booklet, available at www.itu.int/en/ITU-D/Documents/connect2recover/research-competition/Connect2Recover-winning-projects-booklet-final.pdf.

2 ITU, "Information Sessions on Connect2Recover: Research Competition Papers focusing on Africa", available at www.itu.int/en/ITU-D/Pages/events/connect2recover/infosessions-research-competition-papers-focusing-on-Africa/default.aspx.

3 ITU, "ITU's 'Best practices and recommendations for digital inclusion through resilient infrastructure'", available at www.itu.int/en/ITU-D/Regional-Presence/Africa/Pages/EVENTS/2022/P2C_Addis.aspx.

Figure 1: Key highlights of research competition

Research stories

The 15 research reports are a compilation of stories and lessons learned from the front line during the COVID-19 pandemic. These include case studies, focus groups and interviews collected from 17 countries in Africa, Asia-Pacific, the Americas and Arab States. The research reports are organized into sections, shown in Figure 2, as follows:

- Digital inclusion in health;
- Digital inclusion in education;
- Digital inclusion for enterprises and jobs;
- Digital inclusion for vulnerable persons; and
- Digital connectivity and resilience.

Section 1 focuses on digital inclusion in health. The first two research reports explore the technologies and solutions required to overcome the challenges in providing health services in rural and remote areas. The first research report shares a "network-in-a-box" technical solution – that is portable, low-priced and easily deployed. The solution supports broadband and Internet of Things (IoT) health data, and has the potential to revolutionize health services in rural and remote areas. The second research report describes the successful deployment of communication satellites to deliver telemedicine services in Nigeria. The third and fourth research reports analyse the deployment of telemedicine. While the third report focuses on the needs of Dominica, the fourth report considers the state of telemedicine and the needs of vulnerable persons in Ghana. They collectively assess the challenges, and propose solutions to address health needs, particularly to those in rural and remote areas.

Section 2 focuses on digital inclusion in education. The first two research reports spotlight digital inclusion in higher education. The first compares three higher education systems in Australia, the Philippines and South Africa, while the second focuses on higher education in Ethiopia and the needs of vulnerable students. The third research report addresses the digital divide in education by considering the cities of Benguerir, Morocco, and Nairobi, Kenya. They collectively highlight the challenges in online learning, and propose measures and policies to address them and enhance digital inclusion in education.

Section 3 focuses on digital inclusion for enterprises and jobs. The first research report focuses on the opportunities for micro-enterprises to leverage digital technology in Ghana; the second report investigates e-business usage and digital financial inclusion of micro, small and medium-sized enterprises (MSMEs) in the Common Market for Eastern and Southern Africa (COMESA) region; and the third proposes a roadmap, with the goal of transforming the smallholder agriculture sector into a digital agriculture ecosystem in Botswana. They collectively demonstrate

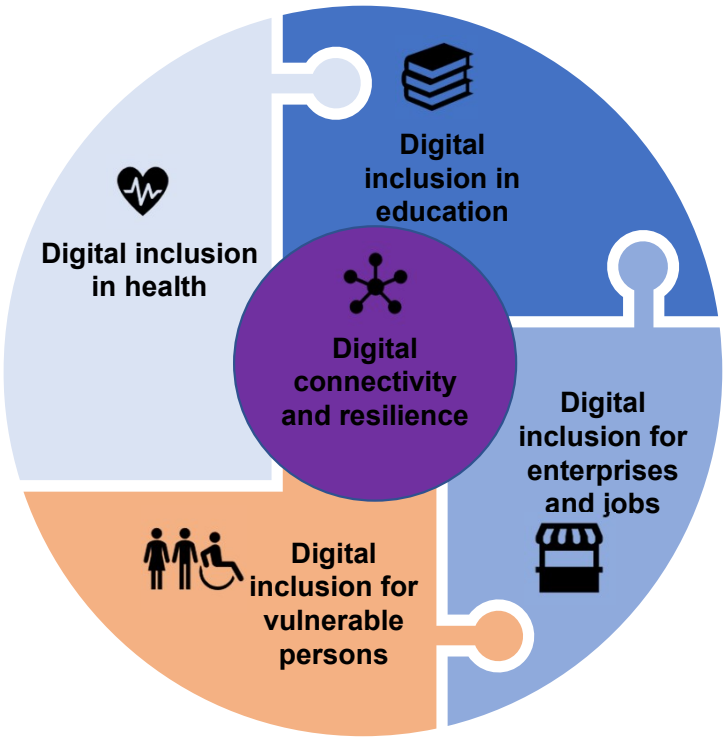
that digital technologies are necessary to transform smaller enterprises and advance the agricultural sector, and effectively improve jobs and livelihoods.

Section 4 focuses on digital inclusion for vulnerable persons. Both research reports focus on challenges faced in accessing digital services. The first report focuses on the vulnerable persons in Uganda and South Africa, and the second focuses specifically on the challenges faced by older persons in Malaysia. They collectively establish the opportunity available to society by empowering vulnerable persons with digital services.

Section 5 focuses on digital connectivity and resilience. The first two research reports focus on Kenya. The first provides a macro view on infrastructure and policies and their impact on the economy; and the second explores the challenges faced by rural counties in the area of education and health, and the opportunity provided by community networks to address these needs. The third report explores the opportunities at the grass-roots level to leverage community networks in South Africa and India. They collectively demonstrate the need to ensure ubiquitous, reliable and affordable services to support the digital inclusion highlighted in the four earlier sections.

These research stories will be detailed in greater detail in the following sections.

Figure 2: Five thematic areas of focus



Lessons learned

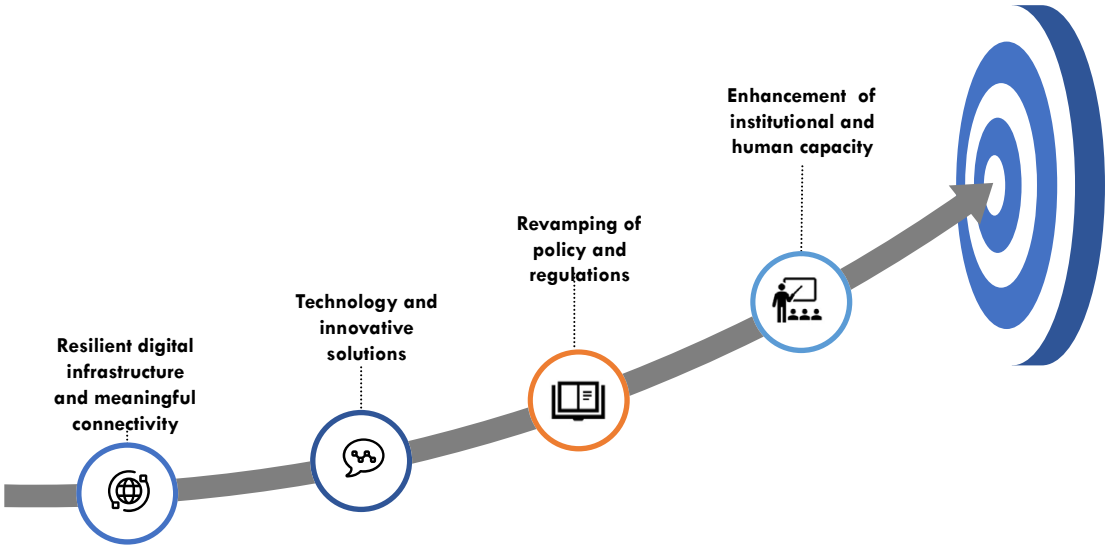
The challenges of digital inclusion and digital connectivity and resilience are not new; nevertheless, the extent of the challenges have been exacerbated during the COVID-19 pandemic. In the current stage of the pandemic, universal and meaningful connectivity and digital inclusion have taken centre stage. As such, the lessons learned from the 15 research

reports are not only applicable to "building back better" in the recovery from COVID-19, but can be applicable to the broader effort to close the digital divide.

The insights and recommendations of the 15 research reports are distilled into four enablers, as shown in Figure 3:

- The first enabler is resilient digital infrastructure and meaningful connectivity. Digital solutions require that the network and infrastructure are ubiquitous and reliable, and that the services are affordable and accessible by all.
- The second enabler is technology and innovative solutions. Digital solutions to enable e-learning, telemedicine, e-business and digital financing are available and should be embraced. The solutions should also be inclusive and accessible by vulnerable persons.
- The third enabler is revamping of policy and regulations. It is recommended that outdated and restrictive policies and regulations be reviewed to ensure that they facilitate technological developments, and are fit-for-purpose and inclusive in nature.
- The fourth enabler is enhancement of institutional and human capacity. Institutions need to prioritize capacity building, particularly in digital skills. This applies to all sectors and institutions – such as health, education and enterprises – and covers health-care providers, teachers, students and employees. Schools should also emphasize equipping their students with digital skills. In addition, vulnerable persons should be empowered with digital skills.

Figure 3: Four enablers for digital inclusion and digital connectivity and resilience



The opportunity

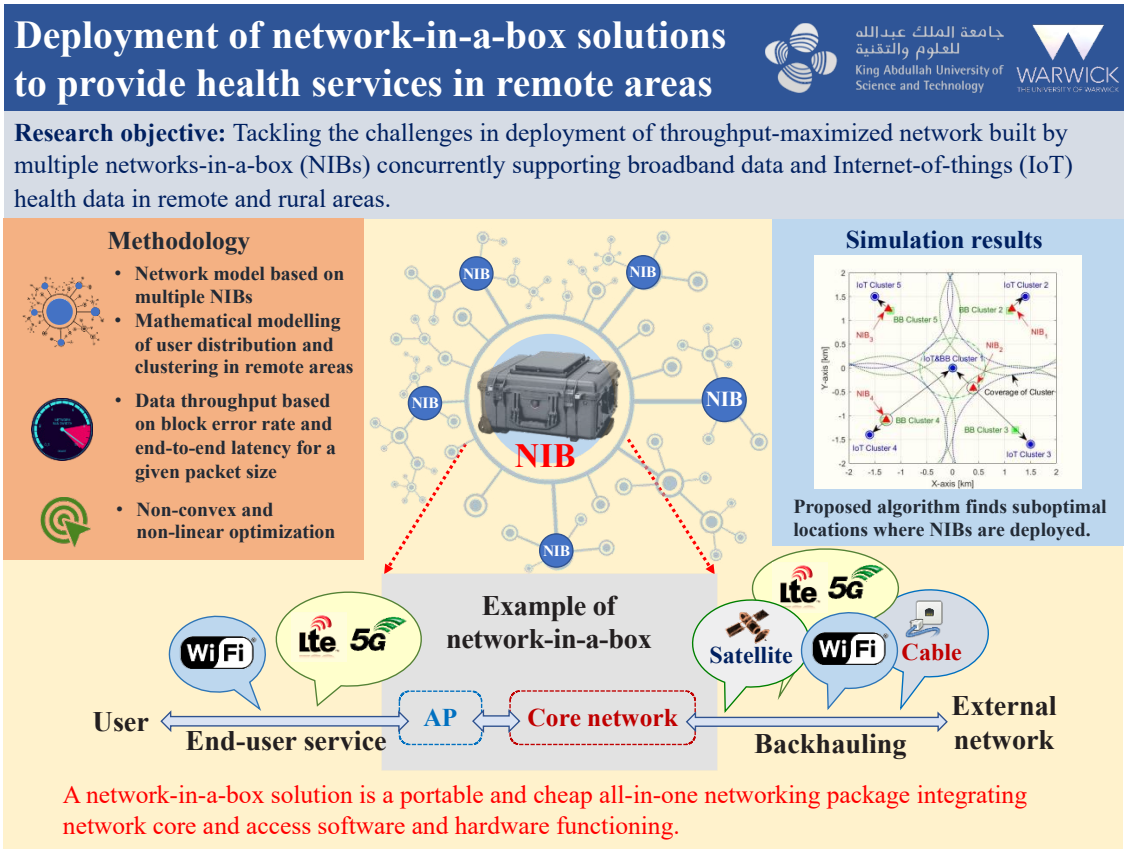
This Research Competition journey that started in July 2021 does not end with the launch of the 15 research reports. In fact, the focus shifts to implementation. We encourage policy-makers to consider reviewing the recommendations and implementing them with impact, as appropriate. Researchers are encouraged to consider the research conducted and to further the work. Finally, we also encourage pilot projects to be conducted or multi-stakeholder partnerships to be formed, and resources to be mobilized, to address these challenges and ensure a more inclusive and connected world.

Section 1: Digital inclusion in health

1.1 Network-in-a-box to provide health services in remote areas

Mr Ki-Hong Park, King Abdullah University of Science and Technology; Mr Mohamed-Slim Alouini, King Abdullah University of Science and Technology; Mr Yunfei Chen, University of Warwick

Figure 4: Deployment of network-in-a-box solutions to provide health services in remote areas



Background

This winning research project involves two research teams: Mr Mohamed-Slim Alouini and Mr Ki-Hong Park of the King Abdullah University of Science and Technology, Saudi Arabia; and Mr Yunfei Chen of the University of Warwick, United Kingdom. Mr Alouini is an active research participant in this project, and is responsible for overseeing all its aspects. Mr Yunfei and Mr Park have capitalized on their expertise to formulate and model the challenge, build a new methodology and discover new findings.

In this project, the team tackled the challenges of network deployment, while concurrently supporting broadband data and IoT health data in remote and rural areas. It introduced a network-in-a-box (NIB) solution, a portable and cheap all-in-one networking package integrating network core and access functioning. It proposed and verified the deployment algorithm to maximize the total throughput in a network supported by multiple NIBs.

Report findings and outcomes

In order to find the optimal deployment of multiple NIBs, the team will face several new challenges:

- First, the end users in rural areas are sparsely located over a wide area, and it is not appropriate to apply a traditional network model. The network topology in this area is likely to be disjointed and irregular, and therefore the user distribution should be modelled by geometrically reflecting and clustering the real user density with reference to local census. The Gaussian density function is used to characterize the distribution of users in a cluster. Its mean and variance reflect the location of the cluster centre and the population concentration in a cluster.
- Second, the team carefully estimated the performance metric that each NIB could provide at one position. The IoT information in health services might have different characteristics, distinguishing it from conventional network data. It requires periodic sensing over multiple wearables, implants and IoT devices on the human body or using wireless sensing through off-body monitoring units. It usually consists of short data packets that are delay-limited, highly reliable and energy-efficient. Therefore, the throughput of health IoT information in rural areas should be characterized by block error rate and latency for a given packet size. The end-to-end latency is characterized by decoding processing delay and transmission delay. Average aerial throughput of IoT health information can be computed under the statistical models of user clustering and distribution. When the IoT health data is limited to a certain latency requirement, the optimal aerial throughput exists with the unique coding rate. On the other hand, the throughput of broadband data can be featured by a fundamental Shannon capacity formula, and averaged over the modelled user distribution and clustering.
- Third, the conditions in multi-NIB-based IoT health networks have to be carefully considered. NIB is capable of supporting multiple networks, but users in different networks will not overlap. This means that the NIB can support low-rate massive IoT health networks, while servicing broadband. Thus, the resource allocation and position of multiple NIBs need to be jointly considered for all networks. Minimum data rate requirements for users and maximum delay constraints for NIBs are constraining the problem of maximizing the total throughput in a network where multiple NIBs are receiving data from multiple IoT health devices and from mobile broadband users in cellular systems.

The optimal deployment of NIBs can be obtained by solving non-convex and non-linear optimization problems with block coordinate descent methods and the relaxation techniques used in its inner loop algorithm, such as successive convex approximation, first-order approximation and linear relaxation. The optimal coding rate for IoT health data and user association are jointly determined in the proposed algorithm. The simulation results have validated that multiple NIBs are optimally deployed near the centre of user clusters for mobile broadband services to provide high data throughput, while maintaining a bias towards serving IoT health clusters to support low-data-rate IoT service.

Insights from the ground

The network environment varies dynamically, as networks are spontaneously and sporadically demanding over time and space. Temporary and intermittent medical sites require network connectivity only during the concerned time or locations. The network has to be resilient to the circumstances confronting the defect and malfunction due to natural disaster or temporary blackout. Accordingly, 6G initiative groups are pursuing the goal of sustaining ubiquitous network connectivity. In this regard, pop-out networking is more advantageous than fixed network infrastructure in dealing with unusual, temporary and intermittent data on demand. NIB is an excellent pop-out solution with limited but user-friendly hardware and software capability,

which saves capital and operation expenditure in a mobile network. NIB perfectly fits in varying environments, owing to ease of deployment, mobility and network flexibility.

Ultra-low latency and ultra-high reliability will be the key indicators to evaluate the quality of physical experience in the private network sectors, based on the extended reality and nearly zero delay interaction in remote rescue and medical operations. Smart ambulances can be ubiquitously connected to the network and provide super-accurate medical assistance. Such potential networks must operate under 5G standards or 6G recommendations. Bearing in mind the advantages of NIB, one consideration will be the manner in which cost-effective NIBs can be used to support these 6G use cases in rural areas.

Key recommendations

- The proposed mathematical modelling of two different communication systems for combining broadband and IoT service enables researchers to further analyse and optimize mobile and heterogeneous networks with latency constraints. If the user distribution and clustering for the target remote areas are modelled precisely, the network operator can deploy and operate a cost-effective, NIB-based network rather than a conventional fibre-optic-based network.
- The proposed algorithm for NIB deployment is a suboptimal solution for finding the positions of NIB to be deployed in the specific network model under user distribution and clustering in sparsely populated areas.
- We should carefully consider the interoperability and coexistence of NIB-based networks along with conventional cellular networks operated by mobile network operators. The mobile broadband users in the town centre and nearby in the rural areas are most likely supported by traditional cellular networks. Spectrum management techniques – such as spectrum sharing, spectrum allocation, or cognitive radio – are required.
- Finally, the user's distribution and clustering in rural areas can vary drastically over time, since the users are sparsely populated, and commercial and residential areas are separated irregularly. The deployment scheduling of NIBs can be dynamically designed over time thanks to the mobility of NIBs.

1.2 Telemedicine as a panacea to medical tourism in Africa: Exploiting communication satellite technologies

Mr Lasisi Salami Lawal, Federal University of Technology; Mr Abiodun Musa Aibinu, Federal University of Technology; Mr Omotayo O. Oshiga, Nile University of Nigeria; Mr Abdulrahaman Jaafar, Federal Airport Authority of Nigeria; Mr Ubong Udoyen, One2One Healthcare and Yale University School of Medicine; Mr Theddeus Iheanacho, Yale University School of Medicine; Mr Steve A. Adeshina, Nile University of Nigeria; Mr Chatwin R. Chris, University of Sussex; Ms Gail Jewell Grose Davey, University of Sussex; Mr Abdullahi Bala, Federal University of Technology; Ms Abimbola Alale, Nigerian Communications Satellite Ltd.; Mr Mohammed Nasir Sambo, National Health Insurance Scheme; Mr Isa Ali Ibrahim, Federal University of Technology.

Background

About the research project

The health service in Nigeria struggles with brain drain, insufficient infrastructure and inadequate specialist skills on the one hand, and affluent patients choosing to be treated abroad on the

other. Medical tourism costs the Nigerian economy approximately USD 1.3 billion annually. Hence, health service for dependent Nigerians, in particular those living in rural and remote areas, is often poor and inadequate. One way to mitigate these shortcomings is to make use of digital solutions, enabling shared specialist resources that reside in Nigerian central health facilities and elsewhere.

Research objectives

- Implement a robust network design to exploit the application of communication satellites to deliver broadband for telemedicine in designated clinics, including mobile very small aperture terminal (VSAT) solutions for medical outreach in rural communities, and internally displaced person (IDP) camps in Nigeria.
- Evaluate the acceptability, utility and adoption of VSAT-based Internet for telemedicine delivered using a peer-to-peer mHealth app (One2One health-care application, currently available free at the Google store).
- Propose recommendations to relevant authorities on VSAT-based telemedicine research findings for inclusion in the National ICT strategy, policy and recommendations to drive digital health inclusion in Nigeria and Africa as a whole.

S4DH stands for "Satellite for Digital Health", designed not only to serve as the team's logo, but also to summarize and capture the objectives of its research.

Research findings and outcomes

Research methodology

The research project draws on a mixed methodology approach comprising:

- Case studies, covering assessment of past telemedicine projects;
- Surveys, covering interviews, consultations and discussions with stakeholders on health-care technologies;

- Action research, covering deployment of VSAT-based Internet with an mHealth app (One2One) to examine and determine the resilience of communication satellite technology to provide telemedicine services.

Research findings

- Communication satellite networks can provide the required bandwidth for effective delivery of telemedicine services in areas with little or no terrestrial mobile networks to fast-track United Nations Sustainable Development Goal 3 (Ensure healthy lives and promote well-being for all at all ages). Robust networks require taking into account equipment sizing, from the gateway of the teleport to the end-user equipment for delivery of efficient broadband services end-to-end.
- Major challenges facing the adoption of telemedicine in Nigeria are language barriers and the low literacy level of the population, especially in underserved communities. A sustainable solution to this issue is the use of support staff to bridge the gap between the digital approach to health-care delivery and the low literacy level of the population.
- The video call feature of the One2One mobile application was essential for the purpose of physical examination, especially in the case of visible skin conditions. This feature is, therefore, strongly recommended for any software developed for providing telemedicine services.
- Poor sanitary conditions and a lack of environmental management, health sensitization and education in IDP camps are major contributors to the prevalent diseases at the camp. Many of them are aware that they have certain medical conditions – such as hypertension, HIV, sexually transmitted diseases, haemorrhoids and diabetes – but they cannot afford the cost of medical care.
- Accessibility of IDP camps to outsiders is not regulated, and may pose security challenges to the inhabitants of the camp.

Results and outcomes

- A total of 766 patients had medical consultations during the Connect2Recover medical outreach and programme.
- A total of 81.8 per cent of the patients and medical personnel who participated in a survey strongly agreed that the One2One mHealth telemedicine services, via VSAT-based Internet, provided an acceptable way to locally deliver health-care services and reduce medical tourism from rural areas to urban centres, including abroad.
- The One2One mHealth application has been made available freely on the Google store.

Key recommendations

Based on the survey, case studies and action research during the six months of the programme, the team proposes the following research outcomes:

- Mobile health applications with audio, video and text capabilities can be leveraged as tools to provide telemedicine services in cities, urban areas where broadband mobile networks are available, and through communication satellites in areas with little or no terrestrial networks, especially inhabitants of rural communities. These applications can also help keep track of medical tourism in Nigeria. Language translation features can be incorporated into such mobile applications to bridge the language and literacy gaps in rural communities.
- Telemedicine can only work efficiently with sufficient bandwidth. Communication satellite networks should take account of end-to-end networks through appropriate traffic engineering, with link budget analysis, to ensure robust and resilient network connectivity for telemedicine services. It is a viable option for providing telemedicine in rural and underserved communities of Africa.

- Satellite-based solutions can be utilized by the National Emergency Management Agency, the Federal Fire Service, and other emergency and disaster management agencies to deliver and extend health-care services to citizens during disaster and emergency situations.
- To foster the inclusion of IDPs in health insurance schemes and coverage, a comprehensive database needs to be created for these vulnerable citizens that includes other palliative measures.
- The Federal Government of Nigeria needs to invest heavily in four key specialties of medicine that account for 60 per cent of medical tourism: oncology, orthopaedics, nephrology and cardiology. Partnerships should be established with hospitals that have specialists in these fields for the incorporation of their services in locally hosted mobile health applications. This will require an increase in the budgetary allocation to the health sector, as well as considerable investments in the Nigerian digital economy.
- Sensitizing the public on the benefits of adopting digital health, especially in university teaching hospitals and other related health organizations, will increase its acceptance rate and adoption in the country.

Insights from the ground

One of the leading gubernatorial aspirants of Akwa Ibom State, Pastor Umo Bassey Eno (see picture below), a native of Ikot Ekpene Udo, travelled over 100 km from the capital city Uyo to his village. He had this to say concerning the telemedicine medical outreach venue: "I have seen the impact of your medical outreach here today with doctors online attending to our people. I will deploy digital health facilities across Akwa Ibom State if I assume leadership as Governor of Akwa-Ibom State."

1.3 The use of telemedicine in the management of chronic diseases in Small Island Developing States: Case Study – Dominica

Mr Benet C. Henry, A-Medic Inc., Optipharm Eye Centre, One Good Deed Inc.; Ms Taletha Laudat, A-Medic Inc., One Good Deed Inc.; Ms Safay Richards, Optipharm Eye Centre; Mr Olugbenga Morebise, All Saints University School of Medicine; Ms Corrie Phillip, All Saints University School of Medicine; Ms Dabria Toussaint, All Saints University School of Medicine.

Background

About the research project

The research team primarily focuses on issues related to health and technology. The team is comprised of a lead researcher, project manager, medical researchers, statistician, research assistance and students from medical institutions. It has facilitated investigative research in the development and implementation of telemedicine in small island developing States (SIDS) in the management of diabetes (DM) and hypertension (HTN). The team aims to produce relevant research that will contribute to the reduction of health inequalities.

Research objective: To demonstrate the importance of telemedicine in the management of diabetes and hypertension, making health care more accessible and affordable in SIDS by 2023.

Research findings and outcomes

Research methodology

The research was a randomized controlled intervention study of two diagnostic groups of DM and HTN classified as chronic diseases. The inclusion of 100 participants in the approved study began in March–June 2022.

The study consisted of a heterogeneous mixture to include the indigenous group: 25 per cent youth, 52 per cent adults and 22 per cent geriatrics; 79 per cent female and 21 per cent male. These 100 prospective participants were selected by multi-stage random sampling stratified into four classifications: DM, HTN, DM+HTN, and Control. A telemedicine platform with HIPPA (Health Insurance Portability and Accountability Act of 1996 (United States)) certification was used. Paired sample t-tests were conducted to determine any statistical differences in the means of variables (weight, blood pressure, random blood sugar) before and after interventions among the various groups (DM, HTN, DM+HTN, and Control). Analysis of variance (ANOVA) was utilized to determine any statistical difference in the means of weight difference (Weight1–Weight2) between groups (DM, HTN, DM+HTN, and Control), and also for determining any statistical difference in the means of these disease groups for the variables Connectivity and Overall Patient Satisfaction with the use of technology.

Research findings

Telemedicine has been an effective medium in the management of chronic diseases in SIDS during the COVID-19 pandemic. The most vulnerable, residing in rural communities, were impacted in the implementation of this project. The digitization of health care has optimized and aided the response to diagnosis, disease monitoring and management during the COVID-19 pandemic. This report presents the overall satisfaction of the management of hypertension and diabetes using a telemedicine platform. Patients in the two diagnostic groups of DM and

HTN were satisfied with the use of telemedicine, which promoted the reduction of waiting time. Irrespective of the distance between a patient's residence from health services, telemedicine was proven successful and no disparity was observed. The competitive edge of the telemedicine platform provided by the use of a smart device increased their ability to consult physicians quickly. The control group was the most satisfied grouping, since it was able to take a proactive approach towards the management of chronic diseases. Participants of the study increased their awareness and knowledge in e-health management systems, by keeping track of their health status, and being educated and updated as patients on new approaches to managing the diseases.

Results and outcomes

1. Telemedicine was an effective tool in the management of diabetes and hypertension.
2. E-health records were established in the management of diabetes and hypertension.
3. Telemedecine can be promoted among diabetic and hypertensive patients for prevention of complications and promotion of good health.

Insights from the ground:

Patient 1: Age range 40–64 years, hypertension and diabetes

"I am a female hypertensive and diabetic patient who was very happy to participate in the telemedicine project. The telemedicine platform enabled me to receive consultations in the comfort of my home. There was reduced waiting time. I am now more confident in managing my hypertensive and diabetic conditions, through advice given by the physician. I have adjusted my diet to improve my health outcome. The telemedicine project has made health care accessible and much more affordable for me."

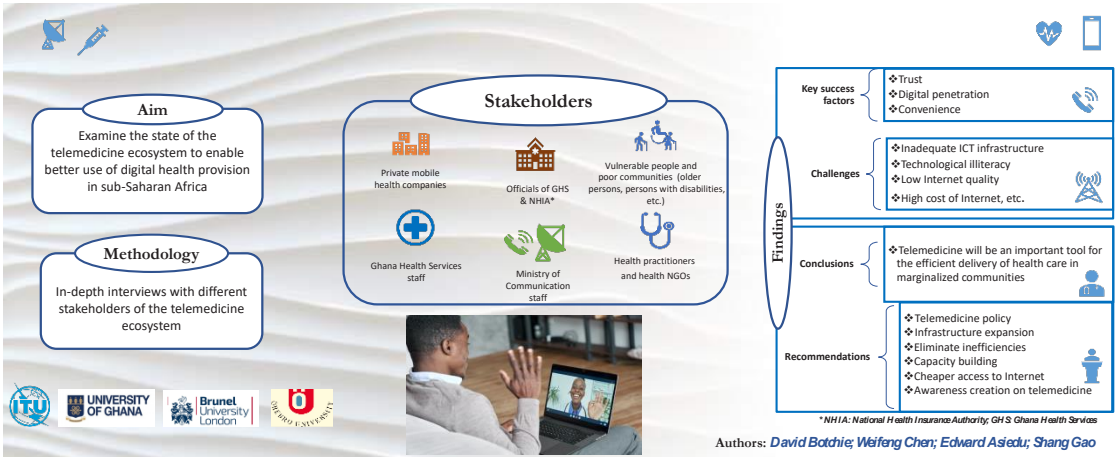
Key recommendations

- Broadband services should be upgraded for improved connectivity of telemedicine services, and satellite and GPS systems should be incorporated in health care.
- There is a need to increase the accessibility and availability of e-health medical devices and technology for improved diagnostics, transfer and record of information.
- Public–private partnerships in the development of telemedicine should be improved.
- Advocacy and education of telemedicine services in SIDS should be increased.

1.4 Improving resilience in developing countries: Digital health provision through telemedicine ecosystem against the pandemic, epidemics and natural disasters in sub-Saharan Africa

Mr Edward Asiedu, University of Ghana; Mr David Botchie, Brunel University; Mr Weifeng Chen, Brunel University; Mr Shang Gao, Örebro University School of Business.

Figure 5: Improving resilience in developing countries: Digital health provision through the telemedicine ecosystem against the pandemic, epidemics and natural disasters in sub-Saharan Africa



Background

Primary objective: To create an understanding of the dynamics of the telemedicine ecosystem and proffer recommendations to facilitate the sustainable adoption of telemedicine in sub-Saharan Africa.

Specific objectives

- To determine the state of the telecommunication and telemedicine ecosystems in sub-Saharan Africa.
- To examine how telemedicine has been diffused to vulnerable groups (older persons, disabled and poor) in sub-Saharan Africa.
- To examine how the telemedicine ecosystem has been leveraged to improve resilience to pandemics, epidemics and natural disasters.
- To determine the challenges and successes of expanding access to telemedicine in sub-Saharan Africa.

Research methodology

The study examines secondary data on the topic across various sub-Saharan African countries, and then concentrates on the telemedicine ecosystem of Ghana using in-depth qualitative tools, including community and focus group discussions, to address its objectives. Primary data were obtained through one-on-one interviews with 63 relevant stakeholders in the

telemedicine ecosystem using a semi-structured questionnaire. Stakeholders in the health and telecommunication sectors, and community members constitute the target population.

Research findings

- Even though telemedicine was not formally in place, people used various digital means to address their health challenges and seek clarifications regarding some symptoms they were feeling during earlier phases of the COVID-19 pandemic.
- Digital penetration, trust and convenience are among the key success factors for a telemedicine ecosystem.
- A telemedicine ecosystem is faced with challenges that hinder the deployment of telemedicine. These include:
  - poor telecommunication and road networks, low ICT capacity of health-care professionals, ICT illiteracy of community members, and financial constraints;
  - the most prominent among these challenges, poor communication network connectivity.
- Government, non-governmental organizations (NGOs) and philanthropists are the main sources of funding for telemedicine interventions. This finding contradicts those studies that conclude that some telemedicine pilots in Ghana were not successful due to lack of funds and little government support.

Results and outcomes

- The telemedicine ecosystem of Ghana is in its early stage and, even though there is improvement in telecommunication services, there are some communities in Ghana with poor network connectivity, which hampers the agenda to expand telemedicine to rural communities.
- Generally, at the policy level, the results show that the telecommunication infrastructure deficit, which has created a digital divide, and policies that do not allow health practitioners in rural communities to attend to some health situations and prescribe certain medication, are the hindering factors to the deployment of telemedicine in Ghana.
- Even though most people are not aware of the existence of telemedicine, they have resorted to various digital means, such as calling friends, health workers they know etc., to seek health advice during the COVID-19 pandemic.
- The success of any telemedicine infrastructure in sub-Saharan Africa will depend to a large extent on the creation of awareness and trust that the digital health services received are of the same quality as those that would have been provided at a health facility.

Insights from the ground

Relevant quotes from participants/interviewees:

- One community member stated: "In my community, the main challenge is network connectivity and the high illiteracy rate. If the people in the community get education about telemedicine and a good network, there will be no issues with it being initiated… the availability of the hardware, not just availability, but its maintenance to be consistent."
- A District Health Director said: "Telemedicine can be used for emergencies and things that are beyond the level of whoever the client is seeing… If somebody collapses, if a pregnant woman is bleeding, if a pregnant woman is convulsing, you can use it. You are attending to someone; you realize the condition has changed and you need to make a call for information; you can use telemedicine."

Key recommendations

Based on the research findings, the study proffers the following recommendations for policy action:

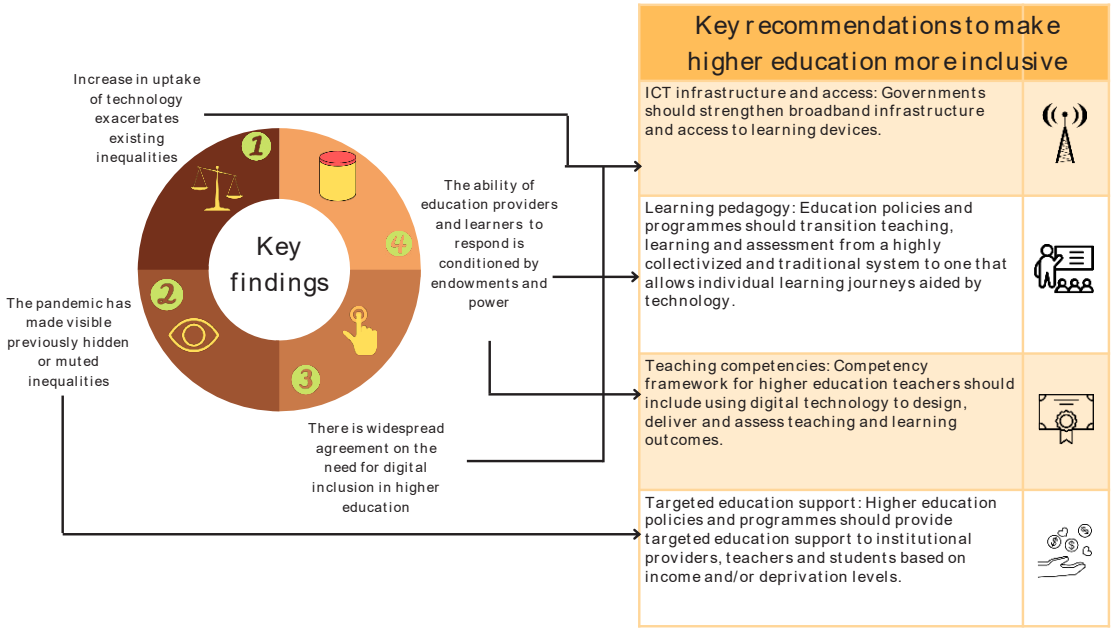
- Health-care policy-makers should constantly collaborate with academia to undertake evidence-based studies to support health-care policy-making in Ghana.
- The Government, in consultation with health-care policy-makers and other policy-makers, should develop a national telemedicine policy to aid in the implementation of telemedicine.
- Health-care professionals and community members should be sensitized to the need to mainstream telemedicine into the health-care delivery system.
- Government should work with the telecommunication companies to address outstanding inefficiencies, such as poor communication networks.
- Ghana Health Service (GHS) is encouraged to consult, design and implement appropriate training modules on telemedicine to build the capacity of health-care professionals.
- The Government should work with the telecommunication companies to implement a toll-free system for telemedicine-related services.
- Ghana Investment Funds for Electronic Communication should expedite action to ensure that telecommunication services are extended to rural communities to support the adoption of telemedicine.
- GHS, through district health directorates, should work with the National Communications Authority to organize clinics to enhance ICT literacy in rural communities.

Section 2: Digital inclusion in education

2.1 Making higher education truly inclusive

Mr Michael Cañares, Step Up Consulting; Mr François van Schalkwyk, Stellenbosch University

Figure 6: Making higher education truly inclusive



Background

ICT infrastructure has proven vital in helping countries and citizens adapt and respond to the COVID-19 pandemic. Whether this reliance has resulted in greater immediate and longer-term inclusion of marginalized communities is an important question in terms of equitable access to higher education.

This report investigates the response to the COVID-19 pandemic by three higher education systems. It also describes the outcomes of these interventions in terms of the inclusion (or exclusion) of marginalized students. Finally, it dissects further the situation as to whether the disruption to higher education – particularly the uptake of new modes of instruction, learning and assessment – results in greater inclusion in the future provision of education.

Report findings and outcomes

Three countries – Australia, the Philippines and South Africa – were selected to study the effects and future outcomes attributable to the COVID-19 pandemic in relation to ICT infrastructure, access and inclusion in higher education. A case study approach was used to study and compare the countries.

Three observations emerge from the South African experience:

- The first is the realization that, as predicted by scholars, neither technology nor open resources necessarily lead to the anticipated democratization effects. Instead, in highly unequal societies (and university systems), an increase in the uptake of technology and open resources is more likely to exacerbate existing inequalities.

- The second observation is that the pandemic has made the invisible visible, especially the historical, economic and geospatial inequalities within and between countries studied. Regardless of the availability of data and devices, the quality of online and other forms of digital educational provision during the pandemic remains open to question.
- One more positive observation is how the pandemic has brought together government, higher education institutions and private mobile operators in acknowledging the greater need for digital inclusion. This atypical cooperation resulted in the provision of devices to students in need as well as "zero-rated" (free) access to university learning platforms and other educational websites and resources.

The case of the Philippines, a system more diverse in its mix of both public and private institutions compared with South Africa, suggests that the capacity of institutions and individuals to adapt to, cope and mitigate the impact of COVID-19 on teaching and learning is significantly differentiated; well-resourced, well-connected, and strategically located actors were more able to transition to new modes of education delivery. Several studies have pointed out that there are differences in processes and outcomes, not only due to resources, but also due to actors such as political leadership, social security provisions, degrees of autonomy and centralization, as well as underlying capacity. Education policies in the country have not considered these differences in capacity, leaving actors to respond and cope on their own.

In the case of Australia, the biggest impact on the higher education sector was the result of the international travel ban and the resultant decline in student fee income from international students. The foreign student market is the third biggest export industry in Australia and the country's largest service-sector export. In terms of the impact of the pandemic on social exclusion, the perilous position of international students stranded in Australia attracted the most attention. Despite some measures taken by the Government of Australia to support these students, the Government's response was seen as largely unsympathetic, vividly expressed by the "go home" response. In general, the effects of COVID-19 on the higher education system in terms of the exclusion of segments of the student population received only cursory attention in the media and the academic literature compared with South Africa and the Philippines.

Insights from the ground

By not succumbing to the hype and allure of new digital educational technologies, and by providing a context-sensitive synthesis of the literature and the surveys conducted during the COVID-19 pandemic, the team has taken a step towards making more explicit the actual conditions and their effects on specific segments of the higher education student populations in South Africa, the Philippines and Australia. By providing an account of how the responses of governments, institutions and the private sector impacted on students with limited resources or abilities, this report has shown the limitations of an overreliance on ICTs for education purposes.

The COVID-19 pandemic has shown that the rapid deployment of technology by various stakeholders is possible. Theoretically, the availability of technologies to a broader segment of the population should result in greater inclusion (that is, participation in communication networks for educational purposes). However, the evidence provided in this report shows that, without the capabilities – many of which are non-material and do not relate to technical skills or access alone – and without an acknowledgement of the social dynamics of systems and networks, parts of the population will always remain excluded.

Key recommendations

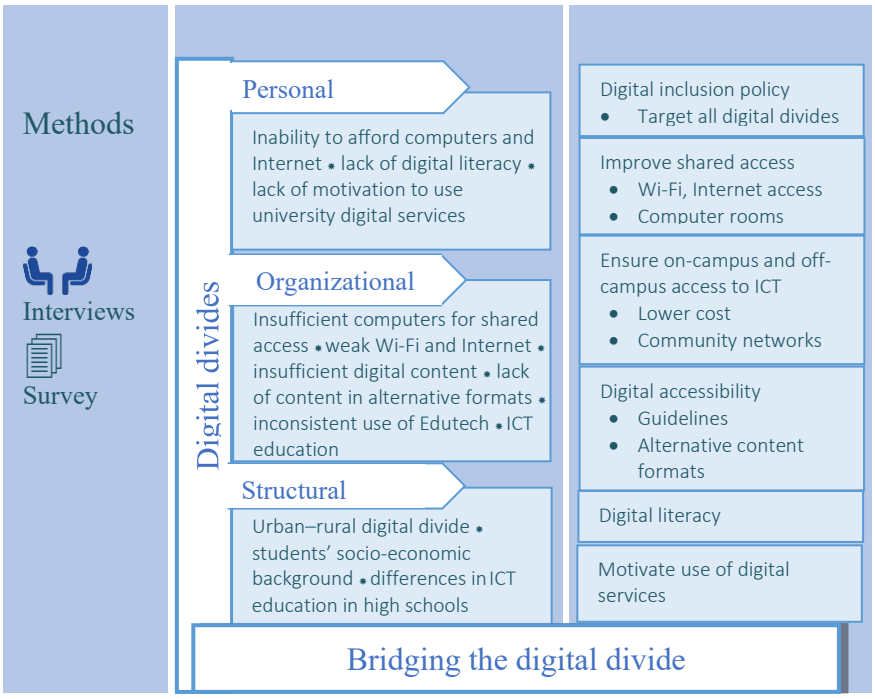
Any future integration of online learning as complementary to contact modes of instruction will require substantial investment in the following areas:

- **ICT infrastructure and access**: In a context where access to technology is challenging, governments should strengthen broadband infrastructure on the one hand, and access to learning devices on the other.
- **Learning pedagogy**: From a pedagogical perspective, there is a need to formulate policies and programmes that transition teaching, learning and assessment from a highly collectivized and traditional system to one that allows individual learning journeys aided by technology. More research is required to understand better the outcomes and impacts of these new modes of teaching, learning and assessment about COVID-19.
- **Teaching competencies**: The competency framework for higher education teachers should include using digital technology to design, deliver and assess teaching and learning outcomes.
- **Targeted education support**: Higher education policies and programmes should provide targeted education support to institutional providers, teachers and students, based on income and/or deprivation levels to transition towards better use of technology in education.

2.2 Determinants of digital inclusion in higher education: Exploring the Ethiopian context

Mr Wondwossen Mulualem Beyene, freelance researcher; Mr Abraham Tulu Mekonnen, Hawassa University; Mr Samson Alemayehu Mamo, Hawassa University

Figure 7: Determinants of digital inclusion in higher education: Exploring the Ethiopian context



Background

ICTs support the United Nations Sustainable Development Goal 4 (Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all) by providing an alternative route to education, as shown during the COVID-19 pandemic, when face-to-face communication becomes inconvenient. However, that requires identification and removal of the digital divide that would create inequalities in ICT access and use. This study aims to explore the digital divide in the Ethiopian higher education context, and recommend solutions that could be used by higher education institutions and policy-makers.

Report findings and outcomes

Five of the oldest universities – including Hawassa University, Addis Ababa University, Arba Minch University, Jimma University and Bahir Dar University – were selected, presumably for their relatively better experience of using ICT. The exploratory sequential mixed method was used in the research. Thus, the research began with in-depth interviews with 15 staff members, including teachers, college deans and ICT directors chosen purposefully from the five universities. The interviews included questions about the respondents' background, ICT access, digital literacy, ICT use and motivation, students' ICT usage, and opinions on barriers of ICT use in education. The interview data was used to design a questionnaire, which was completed by 418 undergraduate students selected from the universities using a stratified proportionate sampling technique. A total of 43 per cent of the students said that they owned PCs, and 90 per cent said they owned smartphones, while 7 per cent said they had tablets. Those who didn't own computers made use of shared access facilities, such as library computer sections (22 per cent) and computer labs (22 per cent), while 10 per cent said they borrowed laptops from friends.

The study identified problems related to ICT access, digital content, accessibility, digital literacy, ICT use and ICT policy. The access-related problems included students' inability to afford computers and Internet connection, an insufficient number of computers in computer rooms, weak Wi-Fi and weak Internet connections. The universities had digital libraries that were not well developed and not accessible outside of university compounds. Learning management systems (LMSs) were underutilized, though they saw improved utilization during the COVID-19 shutdown. The e-learning attempted during the shutdown remained largely inaccessible for undergraduate students, since most of them were from rural areas where there was no access to the Internet. Efforts to address the needs of students with disabilities were limited to production of content in Braille form, and provision of audio recorders to students with visual impairments. There was a lack of knowledge on accessibility and accessibility guidelines.

There are differences in digital literacy among students as well as teachers. Teachers' digital literacy levels have affected the production and delivery of digital content as well as the utilization of LMSs. Those with better ICT literacy would include multimedia content and links to other sources, whereas others were limited to PDF documents and PowerPoint slides. A related problem was inconsistency among teachers in the use of educational technology – for instance, some used LMSs, while others did not. That reflects a lack of institutional norms that govern consistent use of educational technology.

Underutilization of digital services is the other problem. When asked about tools for content sharing, 52 per cent of the respondents said they preferred Telegram, 36 per cent said they would like the materials sent via e-mail, and 11 per cent said they would use university portals.

The little motivation to use university portals was attributed to platform complexity, lack of digital literacy, and teachers' low expectations on the use of LMSs by their students.

Insights from the ground

As one student put it: "I mostly am dependent and feel comfortable with high-end smartphones and I use them instead of computers."

The prevalence of smartphones and students' preference of least interactive technologies such as Telegram imply the importance of incorporating user needs and preferences to develop usable and accessible educational applications.

Removing barriers of access is an important step to digital inclusion. Nevertheless, barriers are revealed through usage. In this research, there were students who did not own computers and had no Internet connection, but said they had not faced barriers. On the other hand, there were others with computers and access to the Internet who listed a number of barriers. Higher education institutions, therefore, would have to promote usage of their digital services and actively work to identify and remove barriers. Maximizing ICT use would require dealing with motivational issues. The use of ICT policies and guidelines would enforce a consistent use of ICT in higher education institutions. Digital literacy programmes would intrinsically motivate students as well as teachers to use ICT to their best advantage.

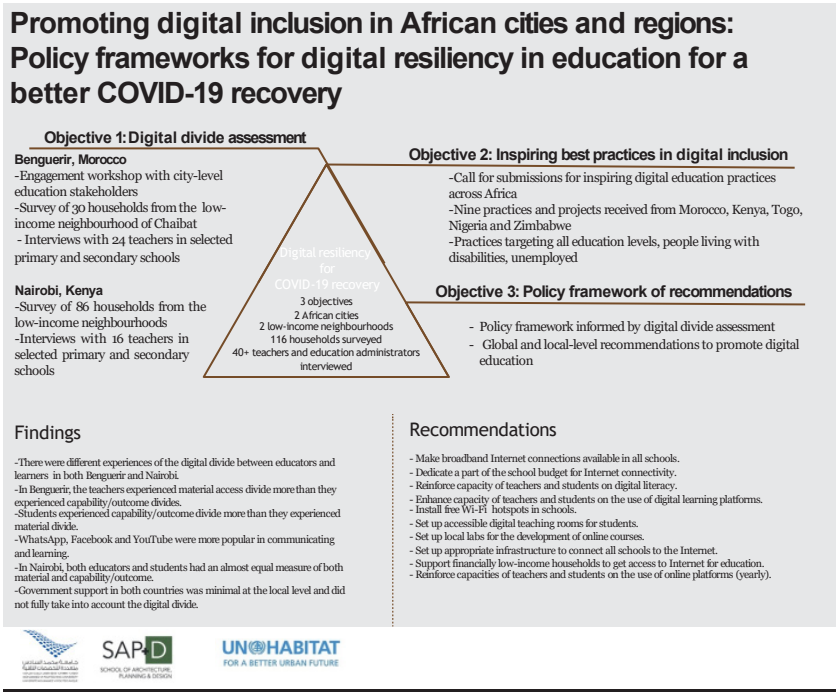
Key recommendations

The first important step could be the development of a digital inclusion policy that recognizes the technical, socio-demographic and socio-economic barriers that are explored in the study. This would help to create a shared understanding of digital inclusion, and institute consistent practices that maximize the use of available educational resources. Thereafter, implementing digital literacy programmes (including computer literacy, ICT literacy, information literacy and media literacy) that target different groups would be important. It would also be important if the existing continuous professional development for teachers incorporated courses and trainings on digital literacy. Establishment of inclusive ICT infrastructures that incorporate the needs of persons with disabilities, working with different governmental and non-governmental partners to ensure on-campus and off-campus access to ICT resources, could be important steps to expand access to ICT and digital services. Digital inclusion in education will not be complete without accessible digital content. Thus, utilization of accessibility guidelines to produce content that can be accessible to all, including students with disabilities, would be important. Moreover, production of content in alternative formats (such as PDF, HTML and audio) would help to address the needs of students with different needs and preferences.

2.3 Promoting digital inclusion in African cities and regions: Policy frameworks for digital resiliency in education for a better COVID-19 recovery

Mr Hassan Radoine, Mohammed VI Polytechnic University (SAP+D/UM6P); Mr Remy Sietchiping, United Nations Human Settlements Programme (UN-Habitat); Mr Hassan Mohammed Yakubu, SAP+D/UM6P; Mr Jieutsa Nkuidje Leandry Junior, UN-Habitat; Mr Solomon Karani, UN-Habitat; Mr Samuel Owuor, University of Nairobi; Ms Khaoula Benaomar, SAP+D/UM6P

Figure 8: Promoting digital inclusion in African cities and regions: Policy frameworks for digital resiliency in education for a better COVID-19 recovery



Background

The research team for the project is multidisciplinary, comprising planners, architects, urban geographers and Geographic Information System experts from UN-Habitat, School of Architecture Planning and Design, Mohammed VI Polytechnic University and the University of Nairobi.

This project aims to develop a policy framework including key recommendations to address the digital divide in education in Africa using the cities of Benguerir, Morocco and Nairobi, Kenya, as case studies. In order to arrive at this overarching aim, three specific objectives are outlined:

- Explore the digital divide and the impact on education in these case study cities.
- Identify and showcase best practices that bridge the educational digital divide during the COVID-19 pandemic across the African continent.
- Propose a policy framework for key recommendations to bridge the educational digital divide on the continent.

A mixed-methods research design was used that made it possible to do a digital divide assessment relying on the UN-Habitat Digital Divide Assessment framework. Specifically, the assessment targeted educators – teachers, education administrators and learners (students) – through their households. The data collection method was through qualitative interviews for educators and a questionnaire survey for students. Prior to commencement of data collection, stakeholder engagement workshops were organized to raise awareness and gather information on the impact of COVID-19 on digital education. Data collection for both target groups was designed and deployed using KoboCollect, permitting easy data extraction and analysis. Additionally, a call for inspiring practices in digital education in Africa was launched to collect good practices in digital inclusion on the continent.

Report findings and outcomes

Findings from the research indicate differential experience of the digital divide between educators and learners during the COVID-19 pandemic in both Benguerir and Nairobi.

In Benguerir, the teachers experienced material access divide more than they experienced capability/outcome divides. Even though they had mobile phones, they were limited in functionality to record teaching material effectively. Their competence in teaching, however, provided an urge to adapt to teaching online. On the other hand, students experienced capability/outcome divide more than they experienced material divide. Most households had one or more mobile phones that students could use. However, they were not abreast of digital learning, which therefore resulted in initial challenges. The city in general did not have locational challenges of connectivity as a material divide. Furthermore, national level assistance such as the TelmidTICE platform was not fully used at the local level. WhatsApp, Facebook and YouTube were more popular in communicating and learning.

Figure 9: Meeting with headmasters at Mohammed VI Polytechnic University in Benguerir

Findings in Nairobi were somewhat similar. However, educators had an almost equal measure of both material and capability/outcome divide during the period. The challenges with connectivity and devices translated into a material divide for them. Likewise, the lack of training posed a capability/outcome divide in their ability to deliver education. For students, the divide in terms of material access and capability/outcome access was similar. The challenges related to socio-economic status in the neighbourhood made it difficult to afford reliable connectivity, thus impacting the capability/outcomes access.

The resulting effect of the digital divide in education in both cities was that it impacted upon the quality of teaching and learning during the COVID-19 pandemic, with repercussions in the long run. Teachers in both cities expressed concern that they had to go over some curriculum elements after the pandemic period in order to assure comprehension of the content by students. On a positive note, the experience of the digital divide and digital education in general opened up avenues for innovative teaching and learning. Some schools pledged to invest in or inculcate digital teaching and learning in their day-to-day classes.

Insights from the ground

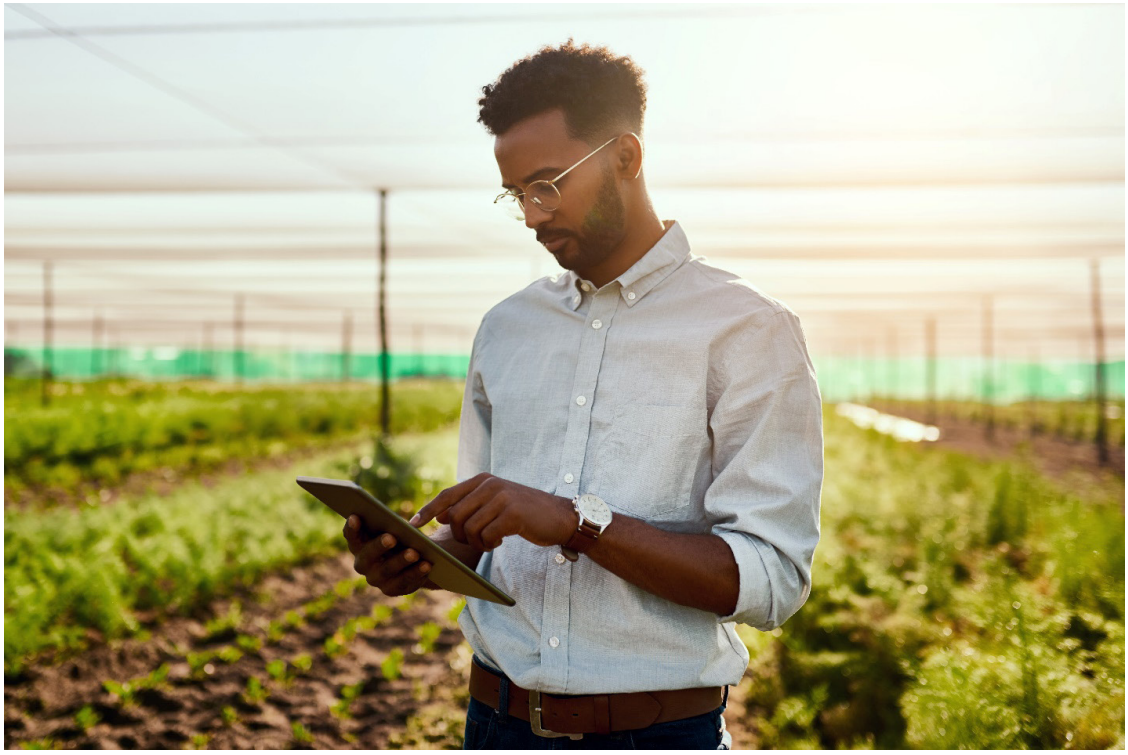
An interviewee insightfully underscored the importance of this new normal in digital education by remarking: "Digital education has improved education to a higher level. It exposes the child and gives knowledge and skills for the future generation. By using this technology, a child can explore more and understand what a teacher may not have explained well in class. Things have changed with time, and our children need to embrace these new teaching and learning opportunities to better themselves in future."

Key recommendations

This research in two case study cities has led to an understanding of the digital divide at the local level through the gaps and roots. The following recommendations will pave the way for action towards a digitally inclusive educational experience with or without emergencies. The recommendations are proposed following gaps and roots:

- To solve some of the identified gaps, introduction of broadband in schools will help, with a part of school budgets dedicated to Internet connectivity. Also, it is recommended to reinforce the capacity of teachers and students on issues of data privacy, cybersecurity and the use of digital learning platforms.
- To tackle the roots of the digital divide, it is recommended to provide the necessary digital infrastructure in schools through the setting up of Wi-Fi hotspots, providing accessible digital teaching rooms, local laboratories for creation of digital learning content in schools. For low-income households, support should be provided to enable them to access the Internet for education.

Section 3: Digital inclusion for enterprises and jobs



3.1 Digital transformation of micro-enterprises in Ghana

Mr Stan Karanasios, University of Queensland; Mr PK Senyo, University of Southampton; Mr John Effah, University of Ghana

Figure 10: Digital transformation of micro-enterprises in Ghana

Method

Micro-enterprises
25 interviews with micro-enterprises in Ghana on how they used digital technology to respond to the impact of the pandemic

Technology firms and government
Interviews with 22 participants from 9 technology firms and Government on how they provided support to business in Ghana

Findings

Technology firms
- Viewed the pandemic as an opportunity to spur further digital transformation across Ghana
- Introduced payment innovations for motorbike delivery, overdraft services for individuals to borrow money using their mobile money wallets and platforms to collect payments
- Spillover effects for micro-enterprises included increased mobile money wallet sizes and transaction limits

Government
- Implemented macro-level initiatives to support the economy, such as Quick Response code for merchant payment and fee waivers

Micro-enterprises
- For micro-enterprises that were able to leverage digital technology in novel ways, the pandemic created opportunities
- The pandemic accelerated digital transformation
- Micro-enterprises became "digital bricoleurs" – they make do by applying combinations of digital technology accumulated over time, freely available or cheaply, to the situation at hand

Digital technology	Level of use
Messaging (WhatsApp, Telegram, etc.)	High
E-mail	Medium
Social media (Facebook, Instagram, etc.)	High
Business website	Low
Selling/buying platform (e.g. Jumia)	Low
Cloud-based apps/storage (e.g. DropBox)	Low
Word processing, accounting software, etc.	Medium
Online banking	Medium-High
Mobile money payment	High
Mobile money loan	Low

Recommendations
- Examine whether the digital bricolage approach should be scaled up or whether it becomes a "digital bricolage trap"
- Create more easily accessible government support mechanisms for micro-enterprises
- Monitor the impact of changes to the costs of using mobile money on micro-enterprises
- Technology firms should develop technology solutions tailored to the needs of micro-enterprises to support them to transition away from the bricolage approach

Background

"Digital transformation of micro-enterprises in Ghana" reports on a study undertaken by Karanasios, Senyo and Effah, associate professors who sought to better understand how resource-poor micro-enterprises in developing countries adapted to COVID-19. They examined how micro-enterprises in Ghana were able to leverage and combine a range of low-cost or

free digital technology – such as WhatsApp, Instagram and mobile money – to reimagine their business while managing their resource constraints and the impact of COVID-19. They interviewed 47 participants across 34 micro-enterprises, government agencies and technology firms. They also drew upon key reports and data from national and international bodies.

Report findings

For micro-enterprises, the authors found that, while the pandemic-induced lockdowns had negative implications, it also created opportunities for micro-enterprises that were able to leverage digital technology in novel ways. For these enterprises, COVID-19 accelerated their digital transformation. They also found that micro-enterprises became "digital bricoleurs". That is, they were able to "make do by applying combinations of digital technology accumulated over time, freely available or cheaply to the situation at hand". For instance, a common combination was mobile money plus WhatsApp plus Instagram. In conjunction with the use of motorcycle delivery services, such an approach allowed enterprises to continue to operate and sometimes thrive. In addition to cost, for these enterprises, such technologies had several taken-for-granted advantages. They were used in everyday contexts, meaning owners were familiar with them; they were easier to handle and took up less physical space (for example, files stored in the cloud); and they tied into societal shifts such as a move from cash to mobile payments and sharing information and connecting via social media. In addition to being able to continue operating during strict lockdowns, outcomes included new customers, increased sales and new exploitable niches:

In the words of one interviewee: "Yes, it has really changed the face of my business because, before I was even thinking that I had to get a shop, but now I am able to get more sales… Before I was not even selling much like the way I am doing online now, because I have the platforms. So, the business is really growing, I'm telling you. It's really helping me."

The Government implemented macro-level initiatives to support the economy. For instance, government agencies such as the Ghana Interbank Payment and Settlement Systems and the Central Bank of Ghana rolled out a quick response code for merchant payment and a fee waiver on cross-provider mobile money payments, which supported micro-enterprises to move away from cash-based transactions.

Technology firms viewed the pandemic as a way to spur further digital transformation across Ghana. While their initiatives were positioned to benefit businesses in general, they had spillover effects for micro-enterprises. For instance, mobile money providers increased wallet sizes and transaction limits (up from GHS 5 000 to GHS 10 000). The introduction of payment innovations for motorcycle delivery services to collect payment was also important for micro-enterprises. Other innovations include offering overdraft services for individuals to borrow money using their mobile money wallets and platforms to collect payments. These initiatives were built on an already mature and sophisticated technology–Fintech (financial technology) ecosystem in Ghana.

Key recommendations

This research provides new insights that should stimulate discourse on how to better support micro-enterprises with future contingencies, and to support their digital transformation more broadly.

For micro-enterprises, the study reveals a more positive picture than that which is painted in the literature, because it shows that they are able to break away from the invisible chains of traditional business models and environmental constraints. Future research is needed, however, to examine if the digital bricolage approach can be scaled up, or if it becomes a "digital bricolage trap", whereby "making do" becomes a vicious cycle that restricts growth.

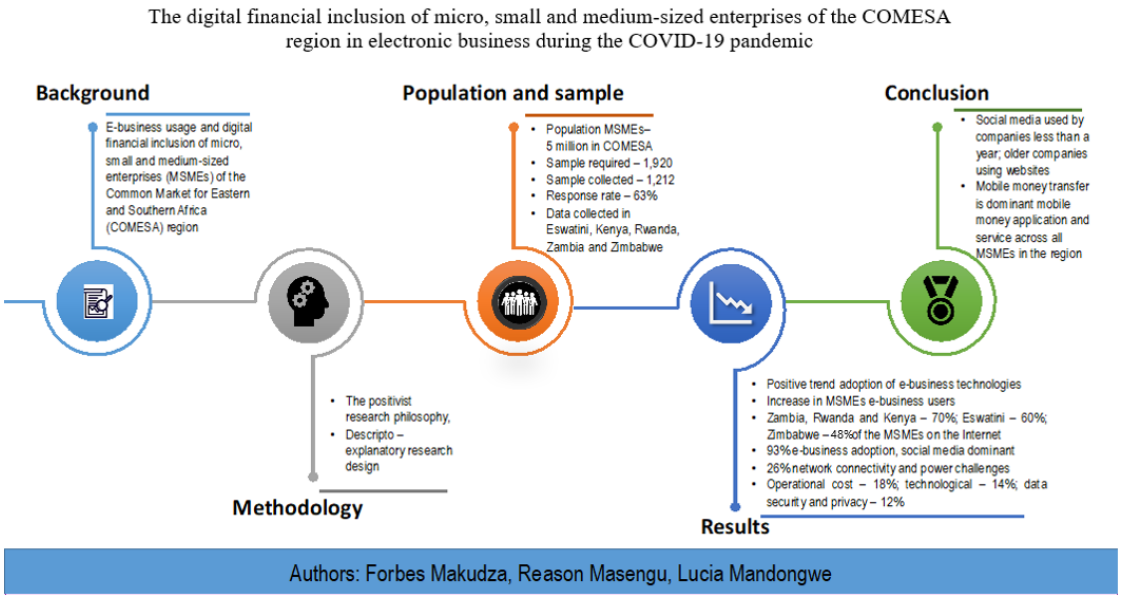
While government support was available in Ghana in the study, no micro-enterprise was able to make use of government support, with several trying but giving up. To overcome friction in this process, more easily accessible support mechanisms are required. Post-pandemic measures, especially the removal of the fee waiver and introduction of an electronic levy on digital payments, could erode the gains made in building resilient micro-enterprises, and thus the impacts of this on micro-enterprises should be monitored.

The authors also recommend that the technology sector consider the needs of micro-enterprises as one of its key focuses. This would ensure that they have mobile payments, mobile loans and other relevant systems tailored to their needs, and support them to transition away from the bricolage approach. Thus, government incentives should be designed to encourage the burgeoning tech sector to support the digital needs of micro-enterprises.

3.2 The digital financial inclusion of micro, small and medium-sized enterprises of the COMESA region in electronic business during the COVID-19 pandemic

Mr Forbes Makudza, Manicaland State University of Applied Sciences; Mr Reason Masengu, Middle East College; Ms Lucia Mandongwe, Manicaland State University of Applied Sciences

Figure 11: The digital financial inclusion of micro, small and medium-sized enterprises of the COMESA region in electronic business during the COVID-19 pandemic



Background

The study was driven by the need to improve e-business usage and digital financial inclusion of the MSMEs of the COMESA region. The study aimed to develop and test a framework that augmented digital financial inclusion through e-business usage among MSMEs. The specific objectives were to examine the dynamic trend of e-business adoption among MSMEs of the region, to analyse the factors affecting their adoption of e-business, and to examine the impact of e-business adoption on digital financial inclusion among them.

Report findings and outcomes

Research methodology

The study used the positivist research philosophy, descripto-explanatory research design and cluster sampling. All 21 COMESA countries were clustered into five clusters using the real gross domestic product issued by COMESA (2020) as the base. One country was purposely selected from each cluster for data collection and analysis. The sampling frame was made up of five countries: Eswatini, Kenya, Rwanda, Zambia and Zimbabwe. Data was collected using a structured questionnaire in a one-off cross-sectional survey. Such a survey involves collecting data from a given population only once at a specific time/period.

Research findings

The study results showed a positive dynamic trend among MSMEs of the COMESA region towards the adoption of e-business tools/platforms and technologies. This was demonstrated by the increasing number of MSMEs using e-platforms, number of gadgets used, and uses of e-business platforms among countries. The results further showed that the key determinants of e-commerce adoption in the COMESA region were not fully explained by the theoretical factors of technology adoption. There was no statistical evidence to support that e-business was driven by simplicity of e-platforms (simplicity), value of e-business (utility), social support (social), e-business infrastructure (infrastructure) or intrinsic factors (intrinsic). The study did find, however, that years in business, years using e-business platforms and country-based differences had an impact on decisions to adopt e-business. On the contrary, the results also showed that e-business adoption did not have a significant association with digital financial services in the region.

Insights from the ground

- The largest proportion of e-business users were found in Kenya, Rwanda and Zambia. Countries in Southern Africa (Zimbabwe and Eswatini) had a slightly less adoption rate compared with countries in East Africa (Kenya and Rwanda).
- The main platforms of e-business in use, in all countries targeted, were websites, social media, mobile money applications and the Internet, in that order. However, the more respondents became educated, the more they moved away from overdependency on social media towards websites.
- Social media was the most used e-business platform by newer MSMEs with operating experience of less than one year; after that, the use of social media declined gradually as the business gained more years of operating experience. Conversely, the use of websites grew gradually as the business gained more operating experience.

- In Zambia, Rwanda and Kenya, at least 70 per cent of the MSMEs had access to Internet banking, while the rate was about 60 per cent in Eswatini. Zimbabwe was the only country where the majority of MSMEs did not have access to Internet banking.
- Money market accounts were very commonly used in the business activities of MSMEs in Rwanda, Kenya and Eswatini. Wire transfers were mainly used in Zambia and Zimbabwe.
- Mobile money transfer was the single dominant mobile money application and service across all MSMEs in the region. Mobile payments, mobile banking and other applications and services did not constitute any significant proportion.

Key recommendations

- The study recommended supporting the establishment and development of e-business models that are aligned with the economic needs of MSMEs of each country.
- It also recommended a transition from cash towards digital mechanisms for e-business platforms, and driving demand and support of the on-boarding of micromerchants onto formal e-business platforms.
- The study informs that policy-making on digital financial inclusion and e-business through country-specific policies as a blanket approach in COMESA may not yield positive results, due to differences in enabling environments among COMESA member States.
- In addition, the study recommends the reduction in the cost of devices and Internet data, so that MSMEs will have the ability to acquire and use the different digital platforms.

3.3 Advancing smallholder agribusiness in Botswana through smart digital innovation

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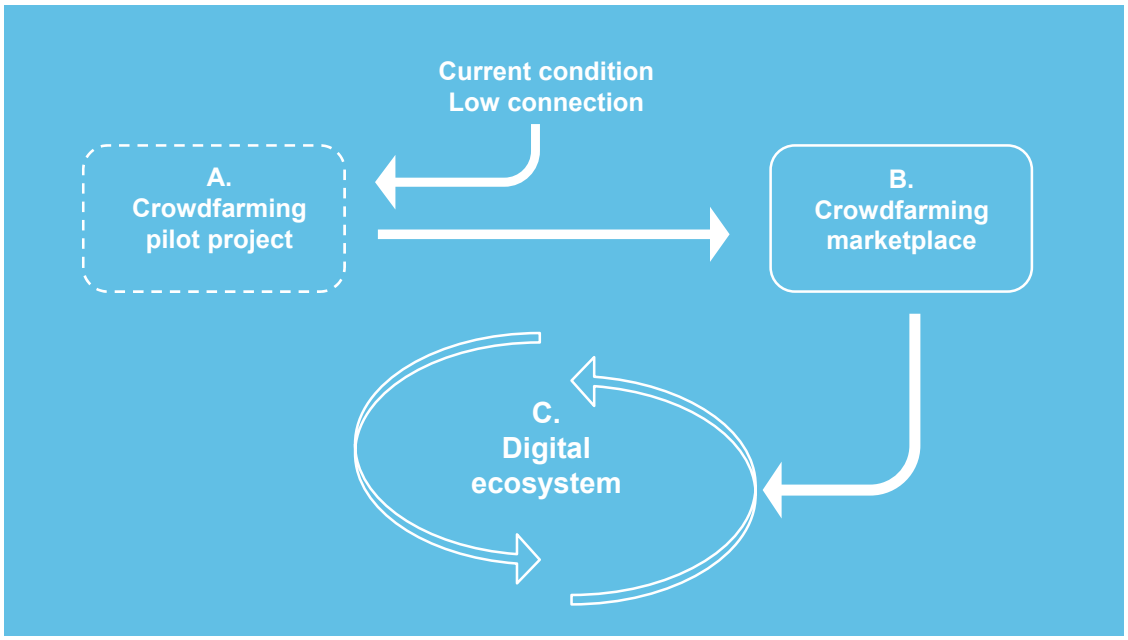
Figure 12: Advancing smallholder agribusiness in Botswana through smart digital innovation



Background

An international research team set out to identify a use case for a federated digital platform that helps to increase resilience and foster innovation in an upcoming post-pandemic Africa. Digital federation enables sovereign data sharing, while ensuring control of the data. It drives the emergence of a trusted and inclusive digital economy, and could foster connectivity in Africa that is constrained by a low level of digital penetration. Based on this technology-driven assumption, and given the continent's size and diversity, the team focused on Botswana as a pilot study, building upon the country's digitalization strategy, SmartBots. It developed a roadmap with the goal of transforming the smallholder agriculture sector into a digital agriculture ecosystem within and beyond Botswana.

Report findings and outcomes

To identify a scalable use case, the project team focused on the smallholding agriculture sector in Botswana. The development needs of the country's primary sector and its low digital penetration level make smallholding agriculture an essential area of technology-driven development. The main result of this study is the definition of a pilot project as part of a longer-term roadmap. As outlined in the full report, the proposed roadmap consists of three stages that are linked as maturity levels of digital transformation: (a) a crowdfarming pilot, (b) a crowdfarming marketplace, and (c) a digital ecosystem for smallholder agriculture.

The starting point of the development plan is the pilot project. It involves the initial participants of a crowdfarming production model and defines their roles, relationships and transactions, which will be represented in a digital tool. Crowdfarming is increasingly used as an innovative, multilocal production model for agriculture, enabling smallholders to plan their harvests better and increase yields, while improving their financial security. Crowdfarming can make the supply chain more efficient, reduce food waste and mitigate the risk of inflation and supply chain disruptions. The pilot is about providing proof of concept and specifying a sustainable business case.

The second phase seeks to develop such a minimal viable tool into a service in the form of a marketplace to attract and increase the number of crowdfarming participants. The marketplace is based on an e-commerce platform and mobile application with defined roles, ordering and fulfilment processes, and financial transactions required to connect farmers with retail and wholesale customers. An organization will operate and further develop the marketplace based on a sustainable income model.

In the third phase, the crowdfarming marketplace develops into a digital ecosystem for sharing data, applications and other digital assets. The ecosystem is based on a federated cloud infrastructure. It will lower the barrier to digital transformation, connecting farmers to new resources, knowledge and markets. The pooling of smallholder farmers and livestock producers will make it possible for smallholders to afford advanced technologies, as they are provided based on an as-a-service business model to serve a large number of farmers through farmer groups or cooperatives. This phase will expand the focus from agricultural production and marketing to a data- and technology-driven approach to precision agriculture and farming as a service, involving agricultural technology companies and start-ups.

The project results have been derived from a hybrid research approach, engaging stakeholders virtually and in person. The research method included qualitative, semi-structured expert

interviews to provide context, a co-creation workshop providing co-design and validation, and secondary research related to the small stock farming and digital development of Botswana. To ensure geographical diversity, research participants were selected from various administrative districts of Botswana.

Insights from the ground

A key premise of this project was that technology alone did not bear the solution to COVID-19 recovery and development needs. Thus, the project team collected stakeholders' voices to test and match the concept of a digital federation platform against local needs. This approach helped to obtain a better understanding of the lived reality of smallholder farmers, as well as their challenges, demands and needs in relation to the digital transformation in Botswana.

Overall, the interviews showed the adoption of technology and connectivity needed to be cost-effective and easily accessible for farmers in underdeveloped regions. It became clear that technology, data access and generation, knowledge sharing and connectivity were necessary to improve the overall resilience of farming activities, thus creating a strong pathway for the sustainable development of smallholding farmers and their close socio-economic environment. As one farmer said: "Thinking to implement a drone system of cameras for monitoring and having an overview of what is happening, if we do not use the technology, the costs for driving there will remain. The problem is the technology is not accessible for many small-scale farmers; it is currently too expensive."

Low digital penetration was raised as the most common issue, in addition to structural challenges related to electricity and water availability, land reform or market access, suggesting the need for a step-by-step digital transformation roadmap.

Key recommendations

Supporting the broader objectives of the ITU Connect2Recover initiative and the digital transformation strategy of Africa, the project set out to identify potential industries, stakeholders and use cases for the development of a federated digital platform and advanced services, with a focus on Botswana. The smallholder agricultural sector of Botswana was identified as an essential area of digital transformation, given the importance and development needs of the country's primary sector. The project team was successful in receiving commitment from actual smallholder farmers, farmers' associations and the Government, to support idea of developing a crowdfarming marketplace and, eventually, an agriculture ecosystem for smallholder farmers, livestock producers and agricultural technology companies. An inclusive, farmer-centric crowdfarming production model with an integrated payment/e-commerce system would help increase overall resilience, financial capacity and production efficiency, due to better market accessibility, direct funding and technology-sharing collaboration opportunities. Crowdfarming was identified as a promising way to increase digital connectivity for remote farmers to relevant agribusiness stakeholders and markets. Thus, the full report is also a proposal for a follow-up pilot project to develop a minimum viable digital marketplace for crowdfarming that connects farmers with consumers in Botswana, providing a funding opportunity for potential partners and donors.

Section 4: Digital inclusion for vulnerable persons

4.1 An assessment of digital inclusion among vulnerable persons in developing economies

Mr Fredrick Kanobe, Kyambogo University; Mr Olusegun Ademolu Ajigini, Icomm Technologies; Mr Denis Ssebuggwawo, Kyambogo University; Ms Bartha Alexandra Nantogo, Kyambogo University; Mr Emmanuel Mukosi, Icomm Technologies; Ms Lerato Moyane, Icomm Technologies

Figure 13: Digital inclusion among vulnerable persons in developing economies: A comparative study between the economies of Uganda and South Africa

<table>
<tr><th colspan="2">Background</th><th colspan="2">Study approach</th><th colspan="2">Influential factors</th><th colspan="2">Study beneficiaries</th></tr>
<tr><td rowspan="3">  </td><td rowspan="3">A century dominated by technological innovations</td><td rowspan="3">  </td><td rowspan="3">Mixed study approach used</td><td>  </td><td>Internet access</td><td>Policy-makers  </td></tr>
<tr><td>  </td><td>Socio-economic status</td><td>Government  </td></tr>
<tr><td rowspan="2">  </td><td rowspan="2">Digital literacy</td><td>ICT industry  </td></tr>
<tr><td rowspan="2">  </td><td rowspan="2">Not everyone is digitally connected, though</td><td rowspan="2">  </td><td rowspan="2">Survey questionnaire (n=620) respondents</td><td rowspan="2">  </td><td rowspan="2">ICT infrastructure</td><td>Researchers (academia)  </td></tr>
<tr><td rowspan="2">  </td><td rowspan="2">Vulnerable persons highly excluded</td><td rowspan="2">  </td><td rowspan="2">Informative interviews (n=20) participants</td><td>Development partners  </td></tr>
<tr><td>Information society  </td></tr>
<tr><th colspan="8">Recommendations</th></tr>
<tr><td colspan="2">Leverage ICT infrastructure</td><td>Avail assistive technology</td><td colspan="2">Digital inclusion awareness and training</td><td>Price-subsidized technology</td><td>Human rights promotion for all</td><td>ICT for older persons</td><td>Appropriate technology</td></tr>
</table>

Introduction

This century is characterized by great innovations in technology. However, not everybody is connected. Gaps persist between individuals when accessing and using various digital technologies. Vulnerable people are more affected. The study aimed at discovering factors that influence digital inclusion for the vulnerable people in the economies of Uganda and South Africa.

Specific objectives

(a) Identify factors influencing digital inclusion in developing economies.
(b) Identify the requirements for digital inclusion in developing economies.
(c) Develop and validate a suitable digital inclusion framework for developing economies.
(d) Provide recommendations on how digital divide reduction can be achieved in developing countries such as Uganda and South Africa.

Research methods

The study adopted a mixed research approach combining both quantitative (survey questionnaire n=620) and qualitative (informative interviews n=20) methods taking a case study of Uganda and South Africa. The study sites were purposively selected, and researched ethical norms observed throughout the study. Quantitative data was statistically analysed with the help of the Statistical Package for Social Sciences application, whereas qualitative data was analysed following thematic inductive data analysis procedures.

Research findings

Key factors that influence digital inclusion in Uganda and Africa include Internet access, digital literacy, ICT infrastructure and socio-economic status.

Study outcome

The digital inclusion framework is based on the four influencing factors developed for Uganda and South Africa.

Highlights from the ground

"How I wish we had computers made specifically for us. We have special needs in technology as special needs learners. We need special computers with special mouse and keyboard and screen," said a respondent in a Special Needs interview.

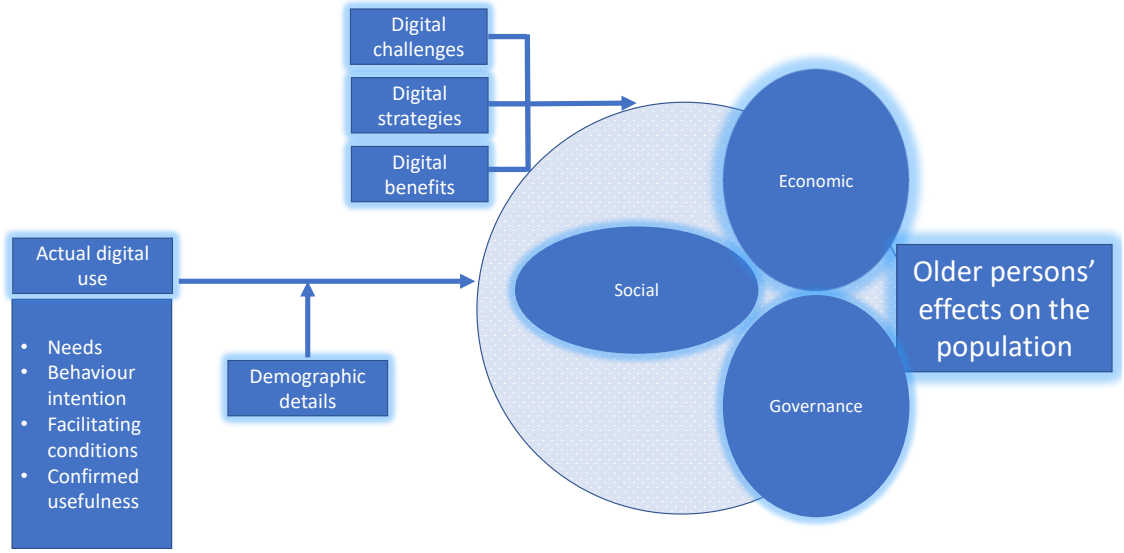
Table 1: Digital inclusion among vulnerable persons in developing economies: A comparative study between the economies of Uganda and South Africa (recommendation and responsible stakeholder)

Recommendation	Responsible stakeholder
Leverage ICT infrastructure in rural and urban areas	Government and private investors
Assistive technology for people with special needs	Government, donors, private sector
Conduct digital inclusion awareness and training	Ministry of education, government, development partners, ICT industry
Subsidize prices for technology devices	Government
Promote human rights for all	Development partners, government, legal entities
Regular review and enforcement of ICT policies	Governments, legal entities, ICT authorities
Avail most appropriate technology for special category of people – blind, older persons, children	Government, private investors, donors

4.2 Reinvigorating older populations in the post-COVID-19 pandemic era through digital inclusion strategies: A case study of Malaysia

Mr Maniam Kaliannan, University of Nottingham, Malaysia; Ms Magiswary Dorasamy, Multimedia University, Malaysia; Mr Ramachandran Ramasamy, Blue Tree Associates

Figure 14: Reinvigorating older populations in the COVID-19 pandemic era through digital inclusion strategies: A case study of Malaysia



Background

This study was conducted under the ITU Connect2Recover initiative to accelerate global digital inclusion during the COVID-19 recovery. It supports the research focus on digital resiliency and digital inclusion to improve the community with broadband. The older population in Malaysia provides an interesting perspective on how digital inclusion can be expanded to a wide range of digital communities in the country and as part of the world's ageing population. Malaysia has achieved an urbanization rate of 77 per cent, and is expected to become an ageing nation by 2030. This research primarily focuses on the digital experiences, behaviours and personal experiences of the population of older persons in Malaysia. Towards realizing the envisaged knowledge-force older population, the research was poised to attain the following objectives:

(a) Examine the perceptions among older persons of the existing digital technology in Malaysia.
(b) Evaluate current initiatives among the Government and others serving the population of older persons in Malaysia.
(c) Prescribe policy strategies for digital inclusion in transforming older persons into a knowledge-force population.

Report findings and outcome

This research adopted a mixed-method design involving several stakeholders. The qualitative data were collected through interviews and focus group discussions, while the quantitative data were collected through survey questionnaires. A total of 418 responses from the targeted older persons were obtained through online and face-to-face interviews. The scope of information probed included demographic details about gender, age group, ethnicity, current working status, living arrangements, digital ownership and 40 variables on the features and characteristics of digital use behaviours. The focus group interviews were directed to policy-makers, development practitioners, caregivers, caregiving institutions, social activists and volunteers.

The conversation with the respondents reveals that actual digital use is influenced by needs, behavioural intention, confirmed usefulness and facilitating conditions. The following are excerpts from the interview, which depict how digital tools and applications can play an important role in lives of older persons towards making changes in their families, social interactions, economic activities and well-being:

- "Technology is important. I feel technology... is useful. We cannot live without it. But we must know how to cope with it. Too much of it is also not good. Addiction makes people lazy."
- "Like I said, it creates impact on most people's lives. You cannot live without technology. You can go crazy with technology. So, we need to create balance when it comes to digital use. You must have certain limits."

Insights from the ground

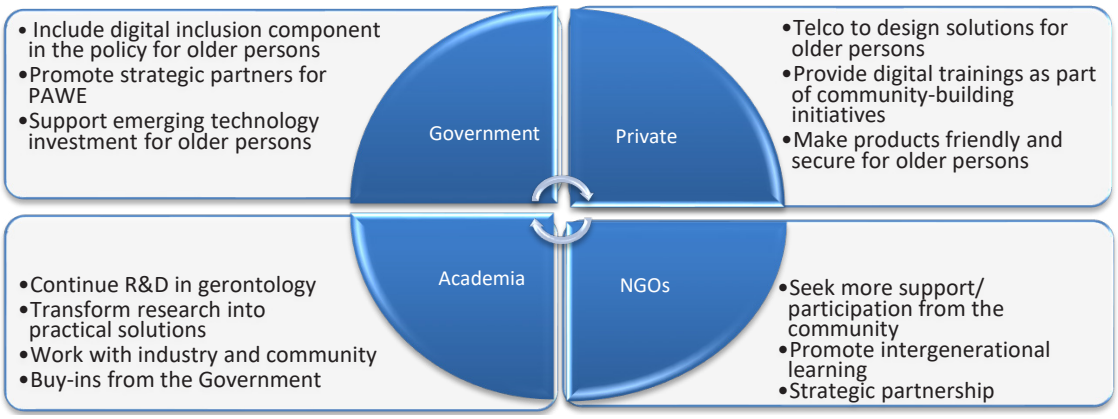
Sentiments from the data collected are as follows:

- "Digital skills for older persons are a must – it is not a new policy that we need, but programmes targeted directly to them. This could be a joint project between government, NGOs and the community in order to make it work. The age where government knows everything is over. Everybody should play an active role in society and community building these days."
- "Collaboration with various parties is important. We need to design specific training for older persons – it begins from basic digital literacy, intermediate and advanced courses, if possible. Older persons also need to be guided, the family members teach them and the community collectively organized such programmes for them."

Key recommendations and conclusion

The main findings from the study pertain to the evidence of the disparity between ICT-savvy and non-ICT-savvy individuals among older persons, and it should be managed by bridging the gap through policies, continuous digital infrastructure development, accessible training and coaching for digital skills. The findings and recommendations are summarized in Figure 15.

Figure 15: The Digital Inclusion Partnership Model



Note: PAWE stands for *Pusat Aktiviti Warga Emas,* the social activity centre for healthy older persons.

Table 2: Representative measures of major parameters by selected demography variables

DEMOGRAPHY VARIABLES	Representative measure	Needs	Digital behaviour	Facilitating conditions	Perceived usefulness	Digital use	Digital strategies	Digital benefits	Digital challenges	Inclusion effect
OVERALL N=(418)	Mean	2.682	2.532	2.512	2.575	2.574	1.921	2.629	1.750	2.099
	SD*	0.404	0.555	0.430	0.462	0.387	0.600	0.370	0.574	0.404
	CV** (%)	15.1	21.9	17.1	18.0	15.0	31.2	14.1	32.8	19.2
MALE (N=260)	Mean	2.7031	2.5423	2.5000	2.6102	2.5865	1.9253	2.6365	1.7909	2.1169
	SD	0.38644	0.48611	0.41399	0.42639	0.35370	0.59803	0.35249	0.59041	0.41098
	CV (%)	14.3	19.1	16.6	16.3	13.7	31.1	13.4	33.0	19.4
FEMALE (N=157)	Mean	2.6459	2.5138	2.5321	2.5175	2.5545	1.9126	2.6168	1.6815	2.0703
	SD	0.43138	0.65425	0.45611	0.51275	0.43729	0.60450	0.39830	0.54106	0.39133
	CV (%)	16.3	26.0	18.0	20.4	17.1	31.6	15.2	32.2	18.9
MALAY N=169)	Mean	2.6675	2.6490	2.5978	2.7809	2.5545	1.9126	2.6168	1.6815	2.0703
	SD	0.43138	0.65425	0.45611	0.51275	0.43729	0.60450	0.39830	0.54106	0.39133
	CV (%)	16.2	24.7	17.6	18.4	17.1	31.6	15.2	32.2	18.9
CHINESE N=(101)	Mean	2.7465	2.2508	2.3540	2.3663	2.4294	1.4088	2.5017	1.2079	1.7061
	SD	0.23814	0.41742	0.26988	0.33646	0.23718	0.33566	0.18333	0.18901	0.16946
	CV (%)	8.7	18.5	11.5	14.2	9.8	23.8	7.3	15.6	9.9
INDIAN N=(140)	Mean	2.6714	2.5923	2.5201	2.4821	2.5700	2.1967	2.6497	2.1086	2.3184
	SD	0.45270	0.53545	0.48037	0.54115	0.46036	0.59969	0.42300	0.56889	0.41931
	CV (%)	16.9	20.7	19.1	21.8	17.9	27.3	16.0	27.0	18.1

* SD = Standard deviation

** CV = Coefficient of variation

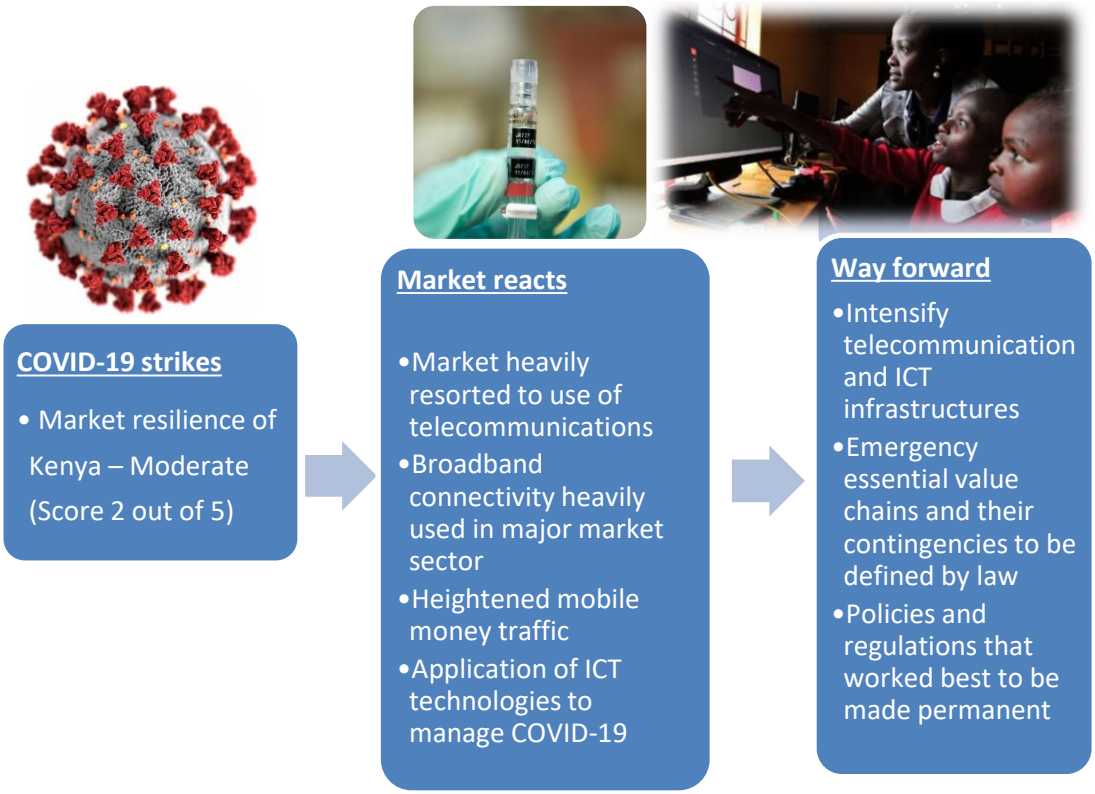
Using the Dragon Fly Model, the team proposed an action plan through the Digital Inclusion Partnership Model, which consists of people, private entities, public entities and partnerships. It recommends that the Government champion this initiative at the policy level by reinforcing digital skills for older persons, supporting the budget for their training and activities, investing in digital infrastructure in public buildings, and supporting and strengthening their activity centres.

Section 5: Digital connectivity and resilience

5.1 Market resilience in emerging digital economies: Case study of Kenya during the COVID-19 pandemic

Mr William Baraza, African Advanced Level Telecommunications Institute (AFRALTI); Mr Jonathan Peter Mwakijele, AFRALTI; Mr Geoffrey Gitau Kamau, Zetech University; Mr Atsushi Yamanaka, Kobe Institute of Computing; Mr Lawrence Dinga, AFRALTI; Mr John Mpapalika, AFRALTI; Mr Stephen Gachogu, AFRALTI

Figure 16: Market resilience in emerging digital economies: Case study of Kenya during the COVID-19 pandemic



Background

This research project responded to the call of Connect2Recover of ITU towards building back better broadband connectivity during the COVID-19 pandemic. It was guided by four specific objectives: to determine the market resilience maturity status; the market changes experienced; the interventions undertaken; and the effects of the interventions during the COVID-19 pandemic in Kenya. Secondary data were collected from quarterly statistics by the Communications Authority of Kenya (2018-2021), while primary data was collected through questionnaires and interviews with various stakeholders.

Report findings and outcomes

The study adopted a resilience analysis model from the European Union Smart Mature Resilience project, due to its holistic nature. This analysis model has been used to determine necessary approaches to enhance cities' capacities to resist, absorb, accommodate and recover from the potentially critical effects of hazards. The framework is conceptualized into four elements

– leadership and governance, infrastructure and resources, preparedness, and cooperation (LIPC) – then measured on a five-scale rating: Starting, Moderate, Advanced, Robust and verTerbrate (SMART). A structured questionnaire on Google Forms was sent to 83 randomly selected institutions involved at national, subnational and regional levels in the COVID-19 response in Kenya. Data collected was summarized into a two-dimensional matrix text map, which found that market resilience in Kenya was moderate (a score of 2 out of 5). Further, analysis of secondary data from the Communications Authority of Kenya statistics reports (2018-21) showed that COVID-19 exerted immense pressure on broadband infrastructure in the country. Further, telephone interviews with selected COVID-19 response agencies and stakeholders in economic sectors showed that responses taken by the Government of Kenya were very useful in the resumptions of the normal operations during and since the peak of the COVID-19 pandemic.

Research findings

Although the new market resilience status was not determined, indications were that clear responses undertaken for countering the pandemic brought significant improvements in the various aspects of resilience. The county governments' resilience was the weakest link in Kenyan market resilience. The heavy use of broadband connectivity for home and increased traffic in courier services calls for enhancing capacity in these areas for supply chain services continuity in future pandemics. Communication and application of ICT technologies for detecting, tracking and tracing, and containing the pandemic, were found to be very critical, as were rapid innovations for emergency response and resilience.

Insights from the ground

The robustness in response to COVID-19 – issuance of fresh produce passes for critical value chain, adoption of e-commerce, and courier services innovations – were very instrumental for business continuity. In the hospitality and entertainment industry, financial crises were halted by the rapid adoption of prevention protocols and vaccination. Broadband Internet services were instrumental for working from home, while innovations for emergency medical services mitigated disruptions on medical services. The raft of economic and social stimuli effectively helped to counter negative social effects – tax relief compensated for lost income, and mobile money service tariffs relief supported cashless transactions. In the end, new normal innovations such as social media marketing are now entrenched: "Nowadays, people post new discoveries of tourism places not known before, for instance, Ololokwe Mountain in the little explored Northern Kenya," according to a respondent from Kenya Professional Safari Guides Association. E-learning and use of radio and television broadcasts and podcasts for academic content have also become firmly rooted.

Key recommendations

The study recommends that emerging economies should intensify their telecommunication and ICT infrastructures for future pandemics. Essential emergency value chains and their contingencies should be defined by law, while those policies and regulations that worked best could be made permanent. To provide valuable communications during emergencies, the Communications Authority of Kenya should also consider allocating spectrum freed in technology reforms to universal access community radio stations. Innovations for emergencies should be encouraged, so as to create local products and services needed for emergencies. The new normal technology-driven policies such as telecommuting and cashless mobile payments

should be made permanent. In addition, cybersecurity should be enhanced for the digital new normal.

5.2 Rebuilding digital inclusion for the rural counties of Kenya

Mr Leonard Mabele, Strathmore University; Mr Joseph Sevilla, Strathmore University; Mr Gilbert Mugeni, Communications Authority of Kenya; Mr Dennis Sonoiya, Communications Authority of Kenya; Mr Edward Wasige, University of Glasgow; Mr Kennedy Ronoh, Technical University of Kenya

Figure 17: Rebuilding digital inclusion for the rural counties of Kenya

Kakamega and Turkana counties of Kenya are a part of the major rural areas of Kenya that were heavily affected by the COVID-19 pandemic.

The team's research investigated the level and opportunity of connectivity for schools and health-care facilities in these two counties.

The team conducted desk review research and a field survey in Kakamega County by visiting a set of schools and health-care facilities, engaged ISPs, and carried out spectrum measurements as part of its research methodology.

While identifying the variables impeding meaningful rural Internet access, the team also unearthed an opportunity through spectrum sharing that can be supported by policy and technical demonstrations to rebuild rural Internet access.

Background

Work on research was carried out by researchers from the following four institutions: Strathmore University, the Communications Authority of Kenya, the University of Glasgow and the Technical University of Kenya. The four institutions provided a great blend of input, ranging from technical assessments and measurements to regulatory and policy guidance. The overall objective of the research was to find out the state of digital infrastructure for the rural counties of Kakamega and Turkana before and during the pandemic. The objective also included assessment of the opportunity that dynamic spectrum access (DSA) through television white spaces and community networks can provide in establishing digital resiliency for such counties, especially in the quest to achieve digital "recovery" from the pandemic. Specific objectives included (a) studying the underlying digital infrastructure for health-care and education sectors in the two counties; (b) determining the level of effect the pandemic had against the previously laid out plans for connectivity; (c) evaluating the opportunity of DSA in the context of newly enacted regulations in Kenya; and (d) development of a baseline mapping tool for the institutions physically visited, as part of field surveys in Machakos and Kakamega counties.

Findings

The research predominantly leveraged the desk research method of study. This allowed various secondary sources relevant to broadband access for the rural counties of Kenya to be studied. Such sources included documentation from the Government of Kenya as blueprints of connectivity for rural Kenya and the country. Other sources of literature included documents by global bodies such as ITU and the Dynamic Spectrum Alliance. In addition to the desk

review research, use of interviews and questionnaires was also exploited to engage Internet service providers (ISPs) in the counties under study, as well as collect data from schools and health-care centres visited during site surveys in Kakamega and Machakos counties. Moreover, measurements were also done in select radio-frequency bands through the use of the regulator's frequency spectrum monitoring truck.

The team's findings show that both academic and health-care facilities in the two counties faced similar challenges at the height of the pandemic. However, Kakamega had a more reliable infrastructure compared with Turkana, particularly in terms of National Optic Fibre Backbone Infrastructure – the country's fibre-optic connectivity initiative. The 4G/LTE spotty coverage affected both students and teachers, who were expected to join online sessions for the continuation of studies. The opportunity to address such challenges through the use of, for example, High Altitude Platform Stations (HAPS), unfortunately, did not live up to expectations. While issues such as lack of alternative access options, affordability, quality of access to data services and content for the students were conspicuously presented for both counties, Turkana was more affected than Kakamega. The field surveys, on the other hand, showed Machakos County to be better connected than Kakamega. Issues identified during the field surveys encompassed cost, backhaul limitations, electrical power and quality of service as variables needing further study. The outcomes of the field surveys were implemented on the ITU Connect2Recover platform (available at https://itu-connect-to-recover.web.app/). The link shows all the schools and health-care facilities visited and their state of connectivity. Conversely, the spectrum measurements conducted showed a window of opportunity that could be exploited through spectrum sharing to provide more alternatives of access to the rural areas of Kenya.

Insights

"We are close to a fibre link but are not connected to it," the Director of Studies at the St. Elizabeth School of Nursing told the team during a site visit to the institution when he shared the connectivity challenges the institution faced before and during the pandemic. This shows that an appropriate mapping scheme needs to be done for rural Kenya to determine the needs versus infrastructure coverage. It would also help stakeholders transform the dark fibre into something useable, and also provided alternative connectivity technologies.

Key recommendations

- Connectivity initiatives for the rural areas of Kenya such as Kakamega and Turkana require consideration of variables beyond infrastructure. That is, stakeholders need to consider needs of electrical power as well as levels of income for such areas.
- Initiatives that can increase access options, such as through spectrum sharing, can be incentivized to allow the set-up of community networks in order to reach multiple unconnected schools and health-care facilities.

5.3 CoLRN: A community-based vision for local resilient networks

Ms Melissa Densmore, University of Cape Town; Mr T.B. Dinesh, Janastu; Mr Naveen Bagalkot, Movement for Alternative and Youth Awareness and Srishti Manipal Institute of Art, Design and Technology; Mr Nervo Verdezoto, Cardiff University; Ms Ndinelao Iitumba, University of Cape Town; Mr Siddhant Shinde, Design Beku; Ms Deysi Ortega Roman, Cardiff University

CoLRN: A community-based vision for local resilient networks

Introduction

The project started with interviews with 25 community wireless network (CWN) members, and continued with two sets of workshops designed to seek community-based viewpoints on how CWNs can be leveraged in the community – from a speculative futuring point of view, a network management point of view, and an eye towards how networks can be leveraged to support local content creation.

Aims and objectives

To discover and understand **current network management challenges and experiences**, and co-design network management interfaces.

To understand the idea of **"network resilience"** in the communities and to support local content creation.

To identify both **strengths and challenges** within the network in the community.

Methods

Participants: Local current and prospective network operators and community network users from Ocean View, DDhills and Channapatna.

1. **Network management for community networks**: 25 Interviews and workshops with local network operators.
2. **Speculative design**: Workshops looking at parallel realities/world building, using situated utopian and dystopian scenarios.
3. **Content creation and dissemination**: The workshops were facilitated to encourage community members to co-create content.

Findings and discussions

- Established new ideas on content creation, e.g community podcasts.
- Challenges with existing network management interfaces, e.g icons, terminologies and finding devices.
- Ad hoc equipment, troubleshooting resources not suited to the level of expertise available.
- Speculative design methods enabled the team to identify both strengths and challenges within community networks.

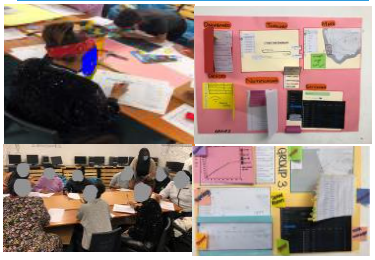


Figure 1: Participants discussing challenges and co-designing network management interfaces for local network operators

Figure 2: Display speculative design workshops, participants using drawings and sketching a day-in-a-life activity to identify strengths and challenges within the communities

Figure 3: Content creation workshop, participants using the PAPAD software as an artifact for content creation and archiving knowledge

Background

People at the edge of the Internet experience unequal access. To address this challenge, the research looked beyond community wireless networks (CWNs) as a means of access to the Internet, and towards a community of local infrastructures that effectively leverage digital technology to bring community members together. The project team conducted a series of design workshops in India and Africa to develop community-based visions for resilient local networks, simultaneously leveraging existing projects around intuitive network management and local content creation to evaluate the design strategies and foster resilience and effectiveness in empowering community networks. The research questions were fourfold: (a) What are community-based visions and requirements for ensuring and fostering resilience and sustainability of CWNs? (b) What are community-based visions for the co-production of local content and services? (c) What design patterns empower CWN operators and community members to manage their CWNs? (d) What design patterns empower community members to contribute to local content and services in a CWN?

Findings and outcomes

Methodology

The studies were conducted in three rural and semi-urban areas of India and South Africa: (a) The Ocean View Community, South Africa; (b) Devrayanadurga Hills (DD Hills), India; and (c) Movement for Alternative and Youth Awareness, Channapatna, India.

The project engaged with methods of qualitative research such as interviews and co-design workshops to understand and design for network management and content creation practices. Crucially, the team used speculative design sessions as a novel method of understanding community visions about resilient local networks. Speculative design is an established approach used for exploring imaginative visions, but is underexplored in the context of participatory research with underserved communities in the Global South. The team drew from the methods of speculative design – such as alternative world-building and structured premises – combining them with the local practices of oral storytelling to facilitate members of the three communities to articulate visions that reveal deeper ideas about resilient local networks.

Findings

- **Community-based visions of resilience and sustainability of CWNs**: The speculative design sessions led the team to formulate a range of community-based visions, defined as design approaches with a primary focus on community voices, but inclusive of the voices of other key stakeholders. The communities envisioned that a reliable network was accessible, sustainable, available and affordable, with strong network signals and high data speed. Networks must be for and by the community, where they will be managed and maintained. The value of the network should be built through word of mouth and marketing of the local content services within the community. Community usage of the Internet/network should be actively fostered – going beyond the current common usage for online shopping, online education, video calls, online commerce and social media, towards creating and sharing locally meaningful content. Jobs can be created within the communities through the network by training people and employing them within the network, and hosting network portals for people to find and apply for new jobs.
- **Network management interfaces:** The team found challenges and experiences of local network operators with existing network management interfaces, including issues with diversity in icons, terminologies, finding and sourcing the right devices, and learning across platform/device interfaces. Another major issue was ad hoc equipment supply chain, and troubleshooting resources not suited to level of expertise available. Having access to an ecosystem of system design experts with resources to train and onboard community members is a great asset in community-centric network management.
- **Content creation:** The team evolved specific visions and ideas for fostering local content creation. Namely, it needed to go beyond singular media and formats, and enrich content creation through supporting multiple forms – digital and physical, audio, video and print – to build on existing forms of storytelling that layer information and knowledge over source material. Additionally, there was a need to help produce content, not only to enhance the knowledge of the community, but to bring different actors and stakeholders of the community closer to grass-roots action – for example, to hold public health institutions accountable – and finding and building smaller communities of solidarity and mutual aid.

Insights

First, a community network is varied, and depends on factors such as state of implementation, community use and engagement, and a collective vision about community infrastructure. The underlying commonality was community engagement. Across all three sites, the desires, intentions and ambitions of key community members – and their actions of conceptualizing, setting up, maintaining, and using the network and its services – held the network together. Secondly, many of the challenges to the resilience of community network infrastructure are already well known, and one way to mitigate is to build the capacity of the community members to operate and manage the network. However, this approach underscores the technical gap – systems that should be easily learnable by a community are simply not usable, necessitating significant training. Finally, there needs to be consistent, long-term ongoing community

engagement around building ownership in the network, its services, and the ways in which the network can foster local creativity and communication. The future research agenda should be to establish truly community-based approaches to content creation that are simultaneously well-situated in the realities of financial and structural constraints.

Key recommendations

- First, enable network for the community, by the community: Train and support community members to enable ownership and maintenance, and co-design of tools, enabling easier networking management.
- Second, support local content design and sharing over the network: Local content enriches local knowledge, enables local economies, and makes the Internet more diverse and equitable. It brings communities together and builds resilience. Community members are well versed in storytelling practices, but need tools and training to easily collect, parse, create and share content that is relevant and meaningful, and in languages of their own.

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