BUILDING THE METAVERSE

A roadmap to scaling XR in Africa

Meta

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Building the Metaverse
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Table of Contents

Acronyms

AfCFTA	African Continental Free Trade Area
AI	Artificial Intelligence
AR	Augmented Reality
AV	Augmented Virtuality
B2B	Business-to-Business
EU	European Union
4IR	Fourth Industrial Revolution
GBS	Global Business Services
ICT	Information and Communication Technologies
IoT	Internet of Things
MR	Mixed Reality
NCAIR	National Center for Artificial Intelligence and Robotics
NFT	Non-Fungible Token
NITDA	National Information Technology Development Agency
OECD	Organisation for Economic Co-operation and Development
STEM	Science, Technology, Engineering and Mathematics
VR	Virtual Reality
WLAN	Wireless Local Area Network
WWAN	Wireless Wide Area Network
XR	Extended Reality

Executive Summary

The Metaverse holds the promise of reshaping how we interact, learn, work, and create.

While traditionally it has been a concept left squarely in the realm of imagination, the unveiling of Facebook's rebrand to Meta indicated the intention to realise this next evolution of digital spaces and spurred increasing interest.

This digital frontier transcends the limitations of traditional screens and devices, inviting us into a fully immersive and interconnected space that spans across platforms, cultures, and continents. In the Metaverse, people can seamlessly navigate virtual landscapes, socialise with friends and strangers alike, and explore limitless possibilities. As this transformative concept gains momentum, it presents a profound opportunity for development, offering new avenues for innovation, collaboration, and economic growth.

But how is this futuristic and seemingly niche technology relevant to Africa?

1 Education & Skilling

2 Job Creation & Income-Earning Opportunities

3 Industrialisation & Competitiveness

In a world being catapulted into a technological revolution, where innovation propels societies forward and unlocks boundless potential, Africa stands at the threshold of its own transformative journey. This report argues that extended reality (XR) technologies are as relevant to Africa's digital agenda as other frontier technologies like artificial intelligence (AI) and robotics, which are increasingly recognised for the development potential of the continent.

| By harnessing the capabilities of XR, Africa has the chance to revolutionise learning, empower its workforce, and drive sustainable economic growth. |

Education & Skilling

The ability to educate and skill Africa's youth to take up in-demand jobs is important for the continent's future.

XR technologies can revolutionise learning by creating immersive learn-by-doing. Virtual reality (VR) particularly has also been shown to improve upskilling and on-the-job training. Research by Deloitte found that augmented reality (AR)-enabled industry training consistently had higher learning retention rates than other forms of training (75% compared to the 5-10% retention rate of lectures and reading).[1]

Job creation & Income-Earning Opportunities

As the world's youngest region, improving earning opportunities for young people is critical to the progress out of poverty.

By 2050, it is projected that sub-Saharan Africa's working-age population will more than double - accounting for 68% of the global growth in the working-age population.[2] The XR market and its applications create the potential for income-earning opportunities. A study by the Analysis Group estimates that the Metaverse could contribute nearly 3% to global GDP over the next decade - equivalent to USD 3 trillion.[3] While most of this value creation lies in the US, Europe and Asia Pacific, Africa is well-placed to tap into global sources of demand. Relatively cheaper labour costs and a younger, digitally-native population positions Africa as a hub for content creators, designers and developers that can export their talents as the world builds the next generation of the internet and virtual experiences.

Industrialisation & Competitiveness

XR technologies can expedite skilling, boost worker productivity and improve information access and exchange, particularly in heavy industries like mining and manufacturing.

VR makes it possible to fully simulate high-cost, high-risk environments in safe, low-cost ways. XR is also positioned to transform retail trade and e-commerce, enabling greater customer engagement with products and revolutionising online shopping experiences. For example, a Nigerian-based furniture company, Taeillo, is using AR to let its shoppers place pieces of furniture in their spaces to engage better with the product.

| This technology is not niche. This concept is not futuristic. It is happening already in small pockets across Africa and in big waves around the world. Africa must not miss the train driving the next revolution shaping the global economy and society. |

Return to Table of Contents

For this to happen, four pillars must be in place across the continent as summarised below.

Figure 1: Readiness themes to leverage XR technologies

| While XR readiness is underdeveloped in the four countries studied - South Africa, Kenya, Nigeria, and Côte d'Ivoire - there is significant potential for growth and improvement. |

Although levels of ecosystem[4] are objectively low, there are important stories to tell about the levels of interest and dynamic community of XR builders across the continent. The ecosystem is severely constrained by a lack of funding, poor awareness and limited access to specialised devices. Connectivity is increasing rapidly across the continent. Yet a digital divide persists, with challenges relating to affordability and connectivity. This divide has ramifications for all opportunities in the digital economy, not only for XR applications. An insufficient supply of advanced digital skills is another key challenge that will require multi-stakeholder collaboration to overcome.

As was the case with improving internet access, it is critical at this early stage of ecosystem development that governments, funders, builders and advocates are crowded in and become awake to the force of XR technologies for driving critical areas of socio-economic development in Africa.

| There is significant but impactful work to be done to get Africa ready for the opportunities presented by XR technology. |

Beyond XR builders, governments, investors and civil society all have a role in the adoption of these technologies. The figure below shows the key pillars required to grow the XR ecosystem on the continent, and the priority items within each of these pillars. While other important levers exist, actions with a high impact potential within the short and medium term were prioritised for discussion.

Figure 2: Recommendations for scaling the XR ecosystem

Scale Awareness & Demand through Coordinated Efforts	Spearhead and drive awareness-building campaigns
	Set up and co-ordinate an African XR Summit and Awards
	Help set up and oversee regional and country level XR associations
	Create open source XR tools and resources
Scale Supply through Long-Term Funding	Set up an XR Fund and Accelerator
	Allocate long-term grant funding towards R&D of XR technologies
	Acquire and retain African XR vendors
Grow Africa's Talent Pool	Create and support on-the-job training programmes
	Create comprehensive online XR courses that cater to an African audience
	Create research centres, knowledge hubs, incubators and community hubs
	Enable the uptake of XR development skills through various funding channels and programmes
Improve Access & Affordability of XR Devices	Set up regional distribution and service centres
	Set up the local production of XR devices
	Lobby for the lowering of import tariffs on XR devices
	Introduce payment plans for XR headsets
Co-Create Adaptive Regulatory Frameworks	Making efforts to build self-regulation as an industry
	Address the need for clear spectrum allocation guidelines
	Address and lobby for industry friendly copyright and intellectual property rights

Introduction

The diffusion of digital technologies and virtual experiences creates new opportunities for development, resiliency and efficiency.

Beyond gaming and social interactions, extended reality (XR) technologies have very real applications for development. From the next generation of surgeons in Nigeria being trained virtually by world-class instructors to tourists anywhere being able to experience seeing gorillas in Uganda without needing to leave their home, and Africa's youth being taught, not through textbooks, but by history, geography and science being brought to life with immersive virtual experiences.

| But currently, only a fraction of Africans can benefit from this. |

The majority of the world is connected to the internet and can therefore benefit from digital technologies. 92% of people living in high-income countries are using the internet, yet across Africa, this is only 40% according to ITU data.[5] Affordability is a critical barrier to connectivity. A fixed broadband connection, on average, will represent nearly 16% of gross national income per capita in Africa in 2022.[6] The Broadband Commission's target is 2% and the world average is just over 3%.

The digital divide is more pronounced among rural populations and the gender gap has remained stubborn at 0.75.[7]

| The enabling environment for digital technologies, including and beyond XR technologies, must match the pace of digital transformation to prevent entrenching inequality and discrimination. |

Bridging this digital divide will require investment in superfast and affordable broadband connectivity, well-functioning data ecosystems, proactive policy, sound regulation and an innovative business sector with the capacity to develop and adopt augmented reality (AR)/virtual reality (VR) applications.

It is against this backdrop that Meta partnered with Genesis Analytics to generate an evidence base of the current state of augmented and virtual reality in Africa, identifying the key opportunities for the application of these XR technologies (namely augmented and virtual reality) for development and barriers to scaling these locally-relevant applications.

The report is structured in three main sections:

Section 1

Firstly, identifying the **headline opportunities for XR** applications that hold the greatest potential for addressing traditional development challenges on the continent in new ways.

Section 2

Secondly, the report **examines the readiness of the continent** to harness XR technologies to realise these headline opportunities. An overview of readiness is presented in this section and **readers are encouraged to refer to Appendix 1 for the detailed assessment**.

Four regionally representative countries were identified to unpack levels of readiness:

Côte d'Ivoire, Nigeria, Kenya and South Africa.

Section 3

With the baseline readiness established, the report then provides **concrete recommendations and a roadmap** for improving overall readiness and scaling the XR ecosystem across the continent.

Methodology

This report followed a three-phased approach. Firstly, the study undertook a rapid landscape of XR technologies - their functions, uptake and applications around the world. From this landscape, key features of the technology were identified. These features were then considered against the continent's development context to identify the headline opportunities for applying these technologies in an African context. This phase was primarily informed through desktop research and firm expertise on African development. Thereafter, deep-dive research was conducted across four key locations: South Africa, Kenya, Nigeria and Côte d'Ivoire. These focus countries were selected in discussion with the Meta African Public Policy unit. They span the continent's key regions, cover both Francophone and Anglophone countries and are among the continental leaders of digitisation.

Over twenty interviews were held with various stakeholders currently working in the AR/VR ecosystem - from developers and creatives to established firms, academics and network facilitators. The full list of stakeholders consulted can be found in Appendix 2. Time was also spent on-site with The Boiler Room where the various technologies and their applications were tested.[8] These interviews were complemented by in-depth country research on the levels of supply and demand, the affordability and availability of devices, the state of digital infrastructure, skills, policy and regulation. This readiness assessment and deep exploration with stakeholders embedded in the ecosystem provided a bottom-up approach to identifying the critical levers for unlocking the opportunities.

The next phase focused on building recommendations for improving readiness and unlocking the opportunities for XR applications across the continent. The central element of this phase was a joint solutions workshop which convened a range of stakeholders into a single workshop to generate granular solutions to scale the ecosystem. The list of workshop participants can be found in Appendix 2.

What are XR Technologies?[9]

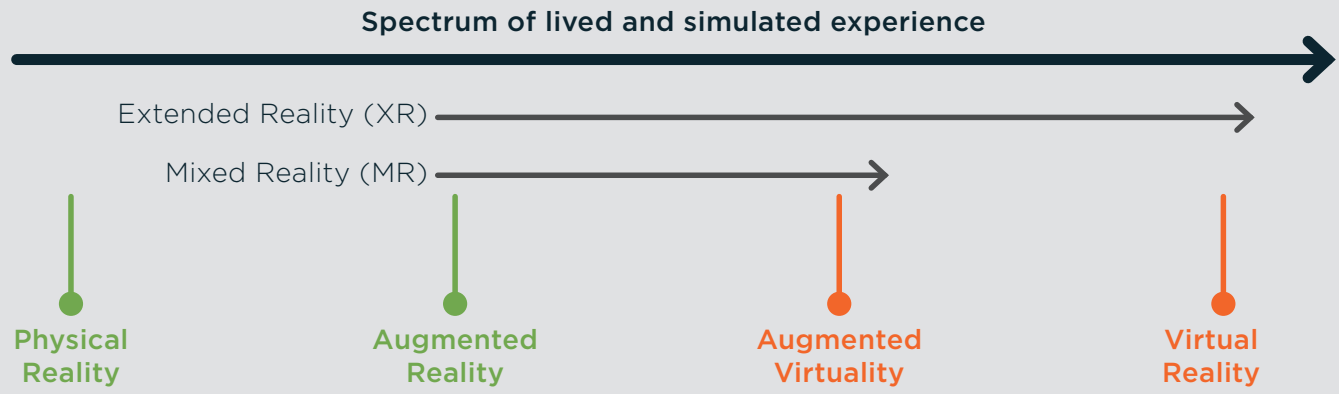
Virtual Reality (VR) is the use of computer technology to create a fully simulated environment that can be explored in 360 degrees. VR creates the sensation of being fully present in a virtual experience where you can interact with virtual objects in a seemingly real way. VR experiences are supported by devices like headsets, motion sensors, controllers and even pressure-sensitive gloves. Training health care professionals can be very expensive and time-consuming. Meta's Quest Pro Headset is now being used by healthcare professionals for training through immersive experiences and simulations, allowing them to virtually practise complex procedures many times over.[10]

Augmented Reality (AR) is a technology that overlays digital images or animations on a person's view of the real world, thereby enhancing, or "augmenting", reality. AR technology has very familiar applications - social media filters or mobile games like Pokemon Go are common uses of AR. However, AR also has very relevant applications in sectors like healthcare, mining, manufacturing and agriculture. For example, a project in the European Union (EU) is using augmented reality to help farmers improve crop management; reduce operation and management costs; and enhance profitability. Farmers receive information on irrigation, machinery operations and crop health collected through drone imagery and the internet of things (IoT) via an AR display.

Augmented Virtuality (AV) is where objects, images and interactions are mostly virtual with some aspects of the real world. This technology has notable use cases in Industry 4.0. For example, AV is being used for quality control where a digitised engine is overlaid on the actual engine for hands-free and detailed quality checks. Prior to AV, this process was done with a physical checklist and printed diagrams of the engine. This technology also allows operators to be sent additional information like assembly instructions, improving the overall efficiency and quality of this process.[11]

Mixed Reality (MR) is where virtual environments and real-world environments interact. Mixed reality technologies recognise real-world space and physical objects in the virtual environment. Augmented reality and augmented virtuality are both mixed reality technologies.

Extended Reality (XR) is the umbrella term for augmented, mixed and virtual reality, immersive technologies. Extended reality has enormous potential to transform the way we work, learn, communicate and experience the world around us. These technologies are core to the Metaverse which is poised as the next evolution in the internet. While still largely unbuilt, **the Metaverse** is envisioned as a set of interconnected digital spaces and immersive 3D experiences.



There are three features of XR technologies that set them apart:

1 **Seamless Insight:** Users of XR technologies are able to access information seamlessly and in real-time. Where previously, users would need to stop to access information on a device, they can now have new information overlaid. Warehouse pickers wearing AR glasses can be directed through the warehouse, prompted to select the correct item and scan the item using the glasses - all hands-free. Moreover, users are able to access information and experiences in a more tangible way. For example, visualising prototypes and scenarios in real space allows users to access better insights.

2 **Real-Feel Connection:** XR technologies bridge geographic distances in a way that more traditional information and communication technologies (ICTs) don't. They improve the experience of connecting remotely, where users have a far more real feeling of being connected and present, allowing people to engage as if they were physically present together.

3 **Unbounded Experimentation:** These technologies, particularly VR, allow realities to be created, altered and repeated in a way that is expensive and time-consuming to do in physical reality. Lowering the cost of simulating different realities encourages experimentation, practice and learning. That these simulated realities are experienced by users in a more real way, supports more memorable learning than what is possible in 2D.

Return to Table of Contents

XR for African Development

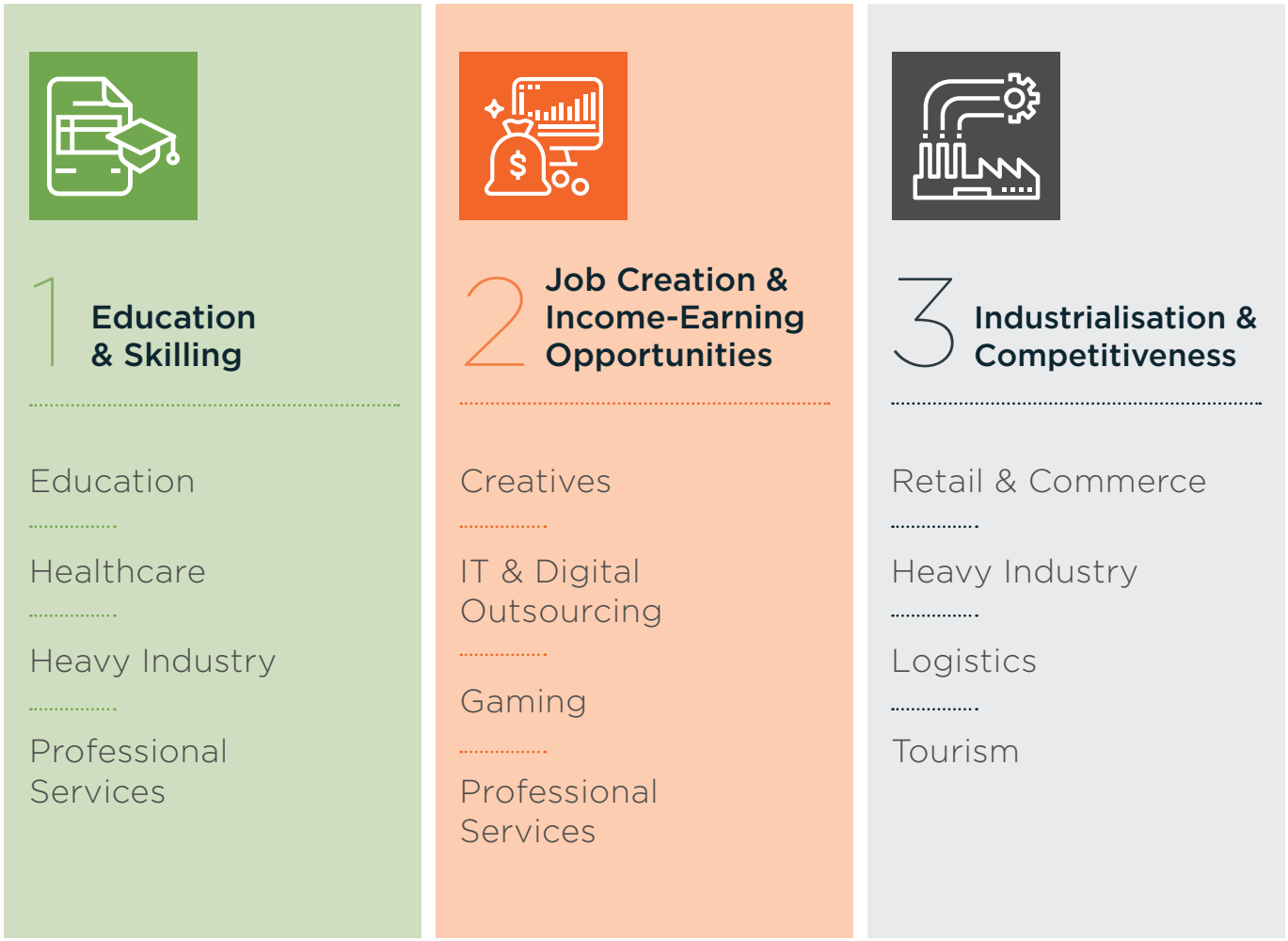
Digitalisation is transforming the landscape of African development and shifting Africa's place in the global economy.

According to GSMA data, sub-Saharan Africa has the fastest-growing mobile economy in the world.[12] Kenya is the undoubted hub of mobile money and Nigeria is a pioneer in the adoption of cryptocurrency. With its young and growing population, Africa is primed for the transformative power of innovation and digital technologies.

| Considering the unique characteristics of XR technologies and Africa's development trajectory, this report identifies three headline opportunities for leveraging XR on the continent (summarised in Figure 3). |

These technologies and their functions are likely to affect traditional sectors in various ways. For example, education could be entirely transformed by immersive experiences enabled by VR. Real-time insights could enhance existing processes in logistics while XR as a market could create new income-earning opportunities for existing professions like coders and creatives.

Figure 3: Sector applications of opportunities for leveraging XR on the continent



Education & Skilling

| The ability to educate and skill Africa's youth to take up in-demand jobs is important. |

According to a UNESCO report, beyond being the only region with the highest out-of-school population - nearly one in four children - sub-Saharan Africa is also the only region where this population is growing.[13] Moreover, educational attainment for those in school is poor. 90% of children in the region are unable to read by the age of 10.[14] Low engagement and poor learner retention rates often stem from a lack of resources.

Moreover, education is typically inadequate in equipping Africa's youth with the requisite knowledge and skills needed for the workforce, with poor alignment of the curricula to labour market demand, therefore further limiting access to earning opportunities. Technical and vocational training can be an effective avenue for skilling, improving workplace readiness and enhancing productivity. But this kind of training is typically recognised as being of poor quality with inadequate training tools and companies tend to prefer higher education degrees.

| XR technologies can revolutionise learning by enabling immersive learn-by-doing. |

Return to Table of Contents

Imagine the shift from rote learning textbooks that may not even be in your first language to putting on a headset and being transported to historical ruins or a wet lab where you can mix chemicals, experiment and see the reactions safely. Moreover, pre-programmed curricula could mean that learning outcomes aren't constrained by the availability of quality teachers. Experiential learning has been shown to elicit far greater engagement and knowledge retention.[15]

| The benefits of experiential learning extend beyond foundational learning to skills building and training. |

A study by PwC found that staff trained using VR were nearly 300% more confident in applying the skills learnt and were trained four times faster.[16] XR has the capacity to streamline the large demand for reskilling and upskilling workforces in an increasingly digitised workspace. Interactive and immersive experiences can make the process of learning systems design, coding and data analysis more engaging and efficient. There are several avenues/applications for training healthcare professionals - from virtually simulating routine procedures to training first responders to cope in dangerous situations. The immersive nature of XR can also open possibilities for teaching soft skills like communication and public speaking. In retail, for example, employees can be trained on customer service scenarios or delivering presentations. Universities across Africa are already employing augmented and virtual reality to train the next generation of healthcare professionals.[17]

> **Traditional resources will never get us to SDG 4 (Quality Education), we must do something radical and radical looks like VR.**
> *- Judith Okonkwo, Founder, Imisi 3D*

Judith Okonkwo founded Imisi 3D in 2016, with the goal of developing the XR ecosystem in Africa. She believes that XR can uniquely solve African problems in several areas including education and that Africans need to be creators in this space, not just consumers.

Imisi 3D is providing the platforms, tools and support to empower XR enthusiasts across Africa and solve local challenges with this new technology. Through communities, training, hackathons, conferences, and labs, Imisi 3D aims to introduce Africans to the possibilities of XR for locally relevant contexts with a particular focus on education.

| VR can enrich learning experiences for children and leapfrog existing education infrastructure deficits. |

Across Africa, there is a critical lack of classrooms, qualified teachers and educational resources. Nigeria has the single largest number of out-of-school children in the world for any one country (10.5 million).[18]

In low-resourced schools, practical learning is rare. Instead of being able to learn-by-doing with wet labs for science, experiments are rote learnt through textbooks. Not only is this problematic for knowledge retention but can also kill curiosity. This is why VR can be truly transformative for education. The immersive nature of VR allows students to feel more engaged and excited to learn.

Imisi 3D runs its own VR for Schools programme, which has been at the forefront of exploring the use of virtual reality as a learning aid in the Nigerian public school system. They collaborate and co-create with public school teachers and have created virtual reality content tailored to the Nigerian Secondary School curriculum with support from UNICEF.[19]

> **VR is a situation where, if you have a room, if you have an all-in-one headset and solar portables, you are literally able to create any environment you want for a child. That's magic. That is the type of magic that allows you to create any learning experience.**
> *- Judith Okonkwo, Founder, Imisi 3D*

| Founded in 1999, The Boiler Room (TBR) is a South African animation and XR development company that employs over 100 people. |

It develops bespoke enterprise XR learning solutions for industry sectors like mining and construction.

> **VR allows us to learn by doing, and we can now assess the realistic 'doing' of the learner in the VR environment.**
> *- Adi Stephan, Chief Learning and Innovation Officer, TBR*

| VR Simulations and training allow high-cost, high-risk processes to be learnt in safe and low-cost virtual environments. |

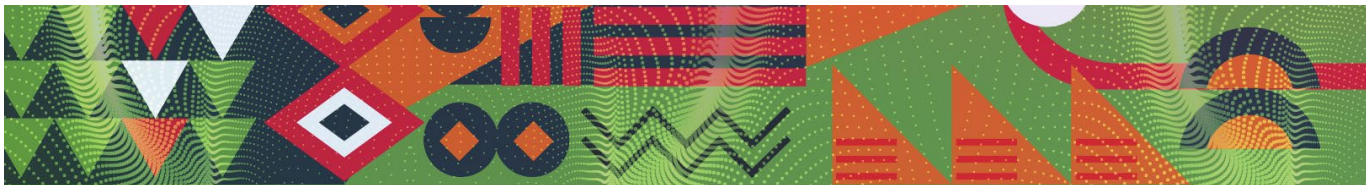
TBR worked with South32, a global mining company, on creating safety and training simulations using AR/VR technology.

Pieter Lange, who oversaw South32's partnership with TBR, states that one of VR's biggest opportunities is improving safety training in high-risk industries. With the implementation of VR training and simulation, safety figures improved dramatically. Since implementing VR training in 2013, the mine has been able to meet its target of zero fatalities.

Operational efficiency was also improved with the deployment of VR tools. VR training on one of South32's machines reduced unscheduled maintenance and down-time from 24 to 4 hours. Virtual training on vehicles and equipment as well as operation also increased operational safety and reduced expenses.

Along with these improved outcomes, South32 were able to reduce total training time by between 30-50%. Similarly, another leading South African platinum mine was able to reduce the time for learners to attain competence by 60% using The Boiler Room's VR operator training.

The scalability of AR/VR solutions allows more employees to be trained more effectively and safely than traditional methods - making VR training a more impactful and affordable tool for these high-risk, high-cost industries. Such benefits in sectors like mining and manufacturing can support industrialisation across the continent and open opportunities for local talent to be effectively trained and employed.



Return to Table of Contents

Job Creation & Income-Earning Opportunities

| As the world's youngest region, improving earning opportunities, particularly for youth is critical to progress out of poverty. |

By 2050, it is projected that sub-Saharan Africa's working-age population will more than double - accounting for 68% of the global growth in the working-age population.[20] This is an unprecedented opportunity for propelling development: The demographic dividend was a major factor in the economic growth of the Asian Tigers in the 1990s.

| However, this dividend can only accrue if there is gainful economic activity available to young people as they come of working age. |

The need to generate millions of new jobs each year over the coming decades is, and will be, the key challenge facing African policymakers.

| The XR market and its applications present significant potential for creating income-earning opportunities. |

The nascency of this space implies the expansive need to build, both the content, applications and software as well as the production of hardware, devices, energy and connectivity. A study by the Analysis Group estimates that the Metaverse could contribute nearly 3% to global GDP over the next decade - equivalent to USD 3 trillion.[21] While most of this value creation lies in the US, Europe and Asia Pacific, Africa is well-placed to tap into these global sources of demand.

Relatively cheaper labour costs and a much younger, digitally-native population, positions Africa as a hub for content creators, designers and developers that can export their talents as the world builds the next generation of the internet and virtual experiences.

| Exporting services and digital skills to meet global demand has already been a significant source of work for African talent. |

The gig economy in Africa is growing rapidly, mainly through digital platforms and e-commerce. A comparative study by IREN estimates across eight African countries in 2018 there were over 250 unique digital platforms supporting nearly five million workers.[22] By our own estimates gig workers accounted for approximately 7% and 10.5% of the workforce in South Africa and Kenya respectively in 2019.[23] Freelancers are prevalent in the African community - the Africa XR Report posits that nearly 40% of survey respondents identified as freelancers, the majority with design and coding skills.[24]

| As the Metaverse becomes mainstream, there will be more demand for African Metaverse developers to design virtual spaces and their use cases. |

For example, Kenyan start-up Virtual Is Real offers Metaverse designer and 3D design services, receiving commissions to create virtual spaces and events in Metaverse worlds like Decenterland and The Sandbox.[25]

| Another major earning channel for digital talent is in the global business services (GBS) sector where global outsourcing operators establish African operations and export services to regional and global clients. |

GBS is already solidifying a position as a significant job creator on the continent with the African GBS market valued at over USD 15 billion and employing over 800 000 workers in 2021.[26] GBS is a particularly attractive sector because it is not limited by the size of local or even regional demand but taps into bigger markets like the US, Europe and Asia-Pacific. The African XR community is already leveraging this model and exporting local talent to international sources of demand - for example, companies in Dubai have recruited ten XR developers from Africacomicade's network.[27] Most of the exported work is currently concentrated in the creative and gaming sectors.

> **There is high demand for African digital content with international studios and development funds increasing investment in the industry.**
> *- Lesley Donna Williams, CEO, Tshimologong*

Tshimologong Precinct is a digital innovation hub in South Africa, operating at the intersection of Hardware, Software and Content (specifically XR).

To meet this demand and grow the sector, the organisation is supporting digital entrepreneurs to ensure product relevance and helping scale and grow their teams. Since 2017, the project has incubated 159 start-ups and 231 entrepreneurs. These include start-ups like Sisanda Tech, an educational AR app awarded the ' Most Innovative Solution' award at the 2019 MTN App Awards.

Tshimologong is providing job-ready digital skills programmes and employment opportunities for unemployed youth and graduates. Their 135 graduates in 2021 have an 85% job placement rate, utilising the Tshimologong networks and incubation projects. Through their various talent placement programmes with partners, like Samsung and Accenture, the organisation has further created 54 jobs and paid internships in 2021.

Taking their success in South Africa to the continent, Tshimologong's Digital Lab Africa project is one of Africa's premier incubators and accelerators for video games and XR content. With 48 incubated projects since 2017, the winners are given the tools and mentorship to help projects scale and improve market access. The 2021 winners include a Nigerian studio, Experis Immersive, which is developing an innovative virtual reality African museum.

Tshimologong's Fak'ugesi African Digital Innovation Festival also offers a showcasing platform for continental premiers of new and cutting-edge XR work, allowing these works to be shown to the industry and audiences. It also works as a key meeting point for intermediaries in the industry for business-to-business (B2B) connections.

While the acceleration of viable digital businesses will stimulate the creation of more jobs within the XR market in Africa, skilling and work placement programmes are equipping unemployed youth with the market-ready digital skills to meet the demand and capacity of this growing sector.

> **With the intention of creating world-leading African digital entrepreneurs, we actively identify emerging talent to create and grow digital ventures.**
> *- Lesley Donna Williams, CEO, Tshimologong*

Industrialisation & Competitiveness

| Historically, industrialisation has been the driving force behind sustained economic growth by boosting value-addition, creating jobs and increasing export revenues. |

The importance of industrialisation for development is evidenced in the role it played in western countries and more recently in the Asian tigers - boosting output and overall levels of income.

| XR technologies can expedite skilling, bolster worker productivity and improve information access and exchange, particularly in heavy industries like mining and manufacturing. |

VR makes it possible to fully simulate high-cost, high-risk environments in safe, low-cost ways. This is transforming employee training but also has implications for product and process design. For example, vehicle safety testing can be done through VR - reducing the time and cost to transition from design to production.[28] Faults on production lines can be quickly resolved through the use of AR where two-way feeds can allow remote specialists to guide local staff through the fault resolution process.

| The African Continental Free Trade Area (AfCFTA) can promote economic transformation and intra-African trade by reducing tariffs, harmonising regulations, and improving foundational infrastructure. |

This is set to benefit 1.3 billion consumers across 55 countries and deliver real income gains of almost USD 450 billion by 2035.[29]

XR technologies are well-positioned to bolster regional trade in two main ways: Firstly, AR can help streamline logistics - a major cost driver of trade. A pilot project by DHL had staff guided through the warehouse by AR smart-glasses to reduce errors and speed up the picking process. The pilot saw a 25% increase in efficiency.[30] This has important implications in the context of growing e-commerce. Secondly, XR technologies promote e-commerce and trade by enabling businesses to showcase their offerings more effectively through immersive customer experiences. For example, a Nigerian-based furniture company, Taeillo, is using AR to let its shoppers place pieces of furniture in their spaces to engage better with the product. Similar applications are occurring in fashion and art.

| XR is also opening entirely new forms of trade and immersive 3D worlds like the Metaverse that can become new real estate in which marketing, customer engagement and trade will occur. |

Traditional in-person experiences, like tourism, can now be exported globally without tourists having to leave their homes. This can attract tourists previously deterred by cost or safety concerns and, importantly, can secure the resilience of the sector amidst growing concern over the climate impact of international travel. XR has implications for other professional services, particularly advertising. The Metaverse and its equivalents are poised as the frontier for customer engagement and retail. AfricaRare - the first African Metaverse - is already seeing big corporates like MTN, Nedbank, M&C Saatchi Abel and Primedia buying up property.

> **I see a future where Africans export XR content and solutions to the West and I'm proud because it's by Africans but for a global market.**
>
> *- Brian Afande, Founder, BlackRhino VR*

Afande's vision for BlackRhino VR is to demystify VR and build the foundations for the mass adoption of this technology. BlackRhino VR specialises in creating XR content and solutions to grow the applications and opportunities for XR services and skills in Kenya and across Africa.

Mainstreaming XR in national tourism sectors can help attract international tourists and build resilience in the sector. Tourism is one of the continent's most important sectors, driving exports and accounting for over 6% of the continent's employment in 2018 prior to the Covid-19 pandemic.[31] The sector is also more inclusive of women and youth.

| With increasing recognition of the climate impacts of international travel and the risk of travel restrictions, XR can increase the resiliency of the sector as tourism can still be exported without the need for physical travel. |

There is a big opportunity to leverage XR technologies to create compelling and immersive virtual travel experiences. Afande says that "360 is still the lowest-hanging fruit and probably 40% of our turnover". BlackRhino VR's 360-degree production promoting *Rhino Watch Safari Lodge* immerses viewers in the lodge's sites and environment, serving as an effective marketing tool for prospective tourists.

VR can also benefit the extended tourism supply chain and job market through marketing and advertising. BlackRhino VR's advertisement for *The Jacaranda House* shows how local hospitality agents are using XR to advertise accommodation and services in the tourism sector. The uptake of new marketing models for the hospitality industry to promote their goods and services can further grow the VR ecosystem, in turn creating a demand for more XR developers and service providers.

Africa's Readiness to Harness XR

Some fundamentals must be in place for African countries to fully leverage these technologies.

These span from basic connectivity infrastructure and skills to strategic agendas and locally relevant use cases. These fundamentals have been grouped into four pillars below.

Robust Ecosystem

Universal Digital Access

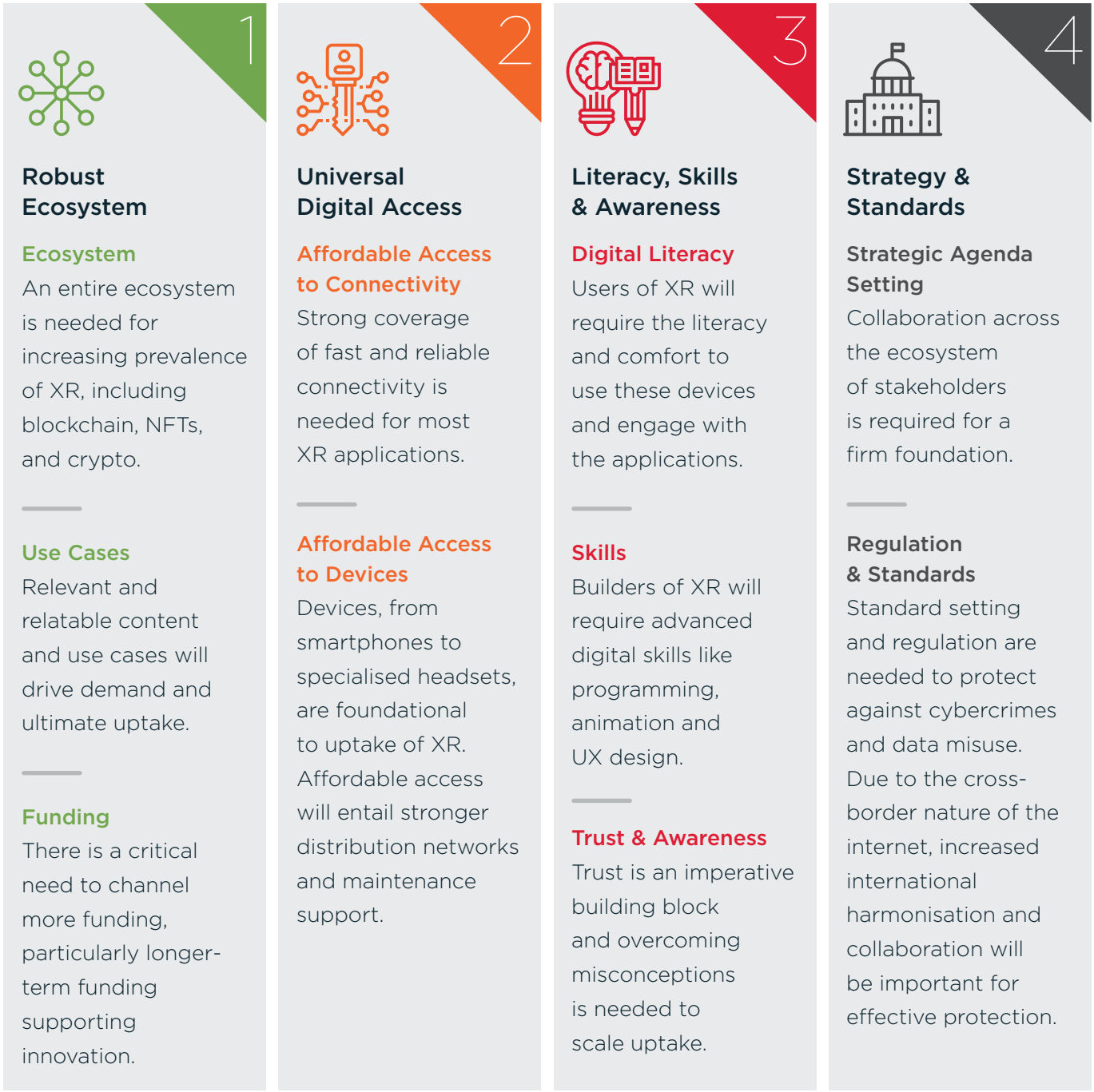
Literacy, Skills & Awareness

Strategy & Standards

The report has examined the levels of readiness of African countries across these pillars to understand where gaps exist so that the right kinds of investments and initiatives can be put in place for African countries to improve readiness and start to really leverage the opportunities presented by this technology.

This section provides an overview of the comprehensive readiness assessment available in Appendix 1 which readers are encouraged to go through.

Figure 4: Readiness themes to leverage XR technologies



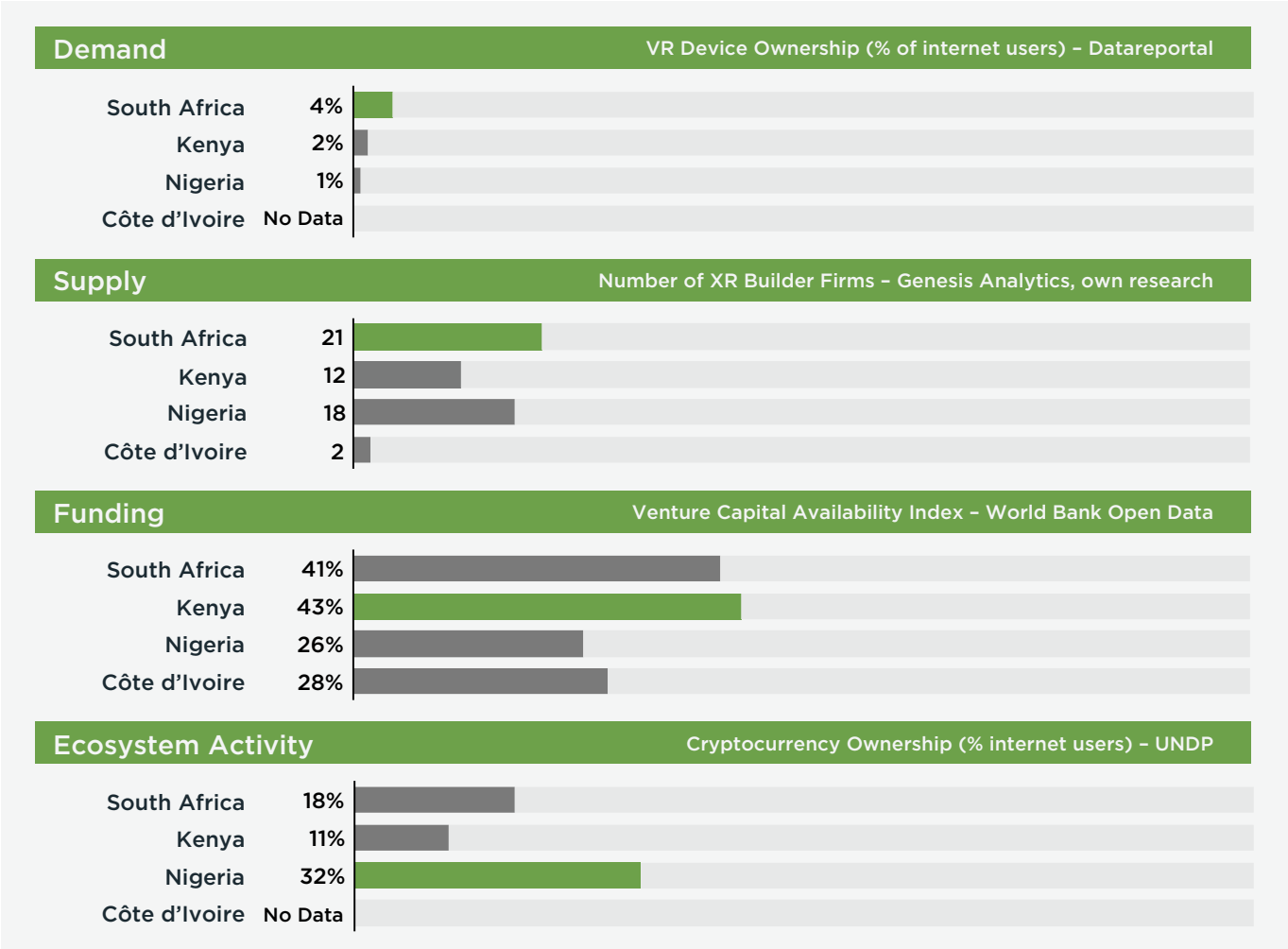
Readiness Theme 1
Robust Ecosystem

| Poor awareness and affordability leading to limited demand is arguably the largest gap across all elements of the readiness assessment. |

Demand in Figure 5 below is measured as the percentage of internet users who own VR devices which is marginal across all four focus countries. However, this is not far off the global average of 4.8%.[32] While the lack of awareness for XR applications is a challenge repeatedly noted by stakeholders, it was the lack of availability of funding that emerged as the number one barrier for stakeholders. Illustratively, by the end of Q3 in 2022, Africa has seen investments in all start-ups of just over USD 4 billion.[33] For comparison, a single US-based XR company - Magic Leap - has been able to raise USD 3.5 billion since its founding in 2010.[34]

Despite the challenges, there is a notable and growing community of XR builders and creatives across the continent, with over 50 different companies[35] building XR solutions across South Africa, Kenya, Nigeria and Côte d'Ivoire. The wider supporting ecosystem of blockchain, non-fungible token (NFT) and crypto adoption is also showing promising green shoots. The annual Fak'ugesi Festival saw almost 700 creatives come together in 2021 to discuss the XR market, NFTS, regulation and funding.

Figure 5: Overview of ecosystem robustness



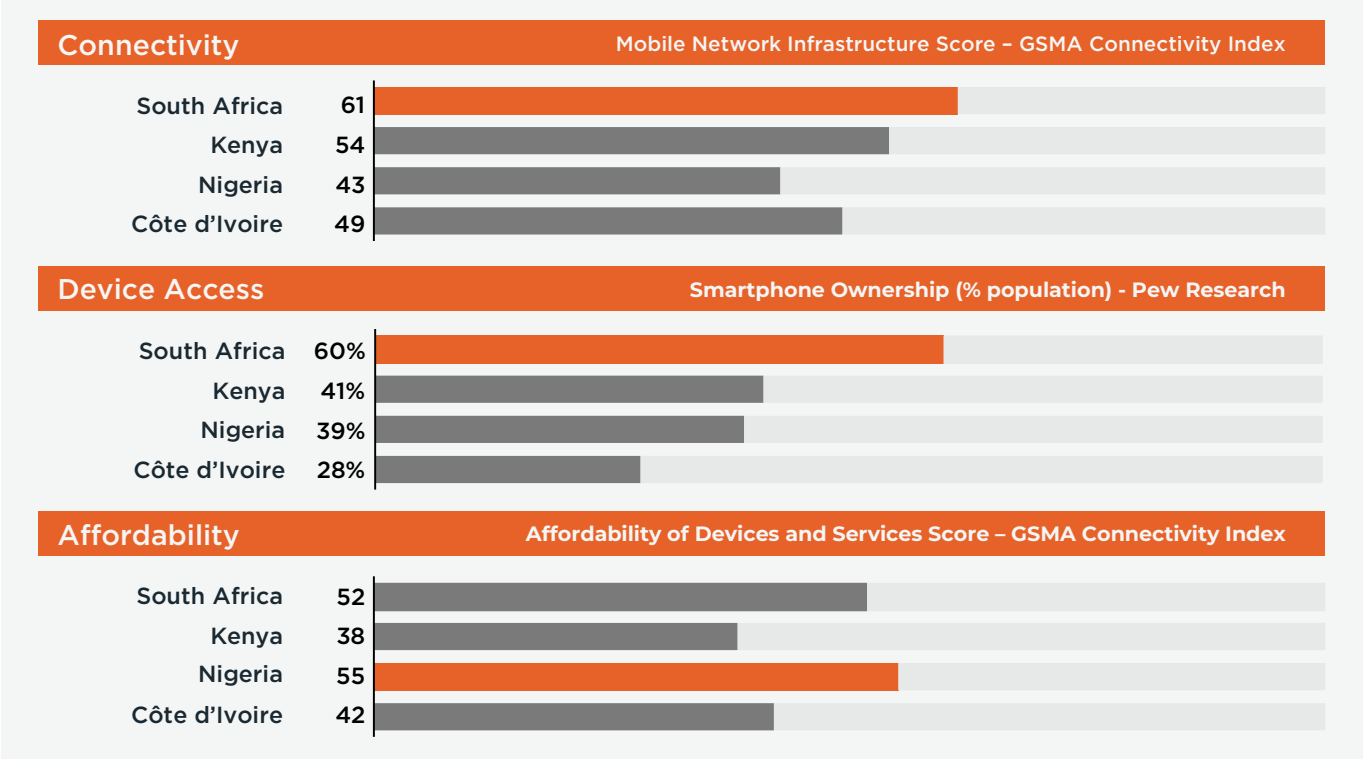
Readiness Theme 2
Universal Digital Access

| Overall levels of digital access are promising yet affordability is a key constraint. |

Levels of connectivity and mobile penetration are steadily increasing across the continent, with mobile phones becoming the prominent channel for unlocking opportunities in the digital economy. Although mobile connectivity is an important gateway to XR applications, fully-immersive experiences will likely roll out over fixed broadband connections. Fibre-optic coverage across all four countries lags behind mobile coverage but is particularly suppressed in Kenya, Nigeria and Côte d'Ivoire.

Moreover, access to and ownership of specialised AR/VR devices is extremely limited. While smartphone ownership is increasing, levels remain below 50% in Nigeria, Kenya and Côte d'Ivoire. Multiple stakeholders noted the lack of authorised distributors or support services for XR hardware on the continent. In a survey conducted by the Africa XR Report, respondents in the XR industry found hardware costs (64%) and hardware availability (54%) to be a challenge for their businesses.[36]

Figure 6: Overview of universal digital access



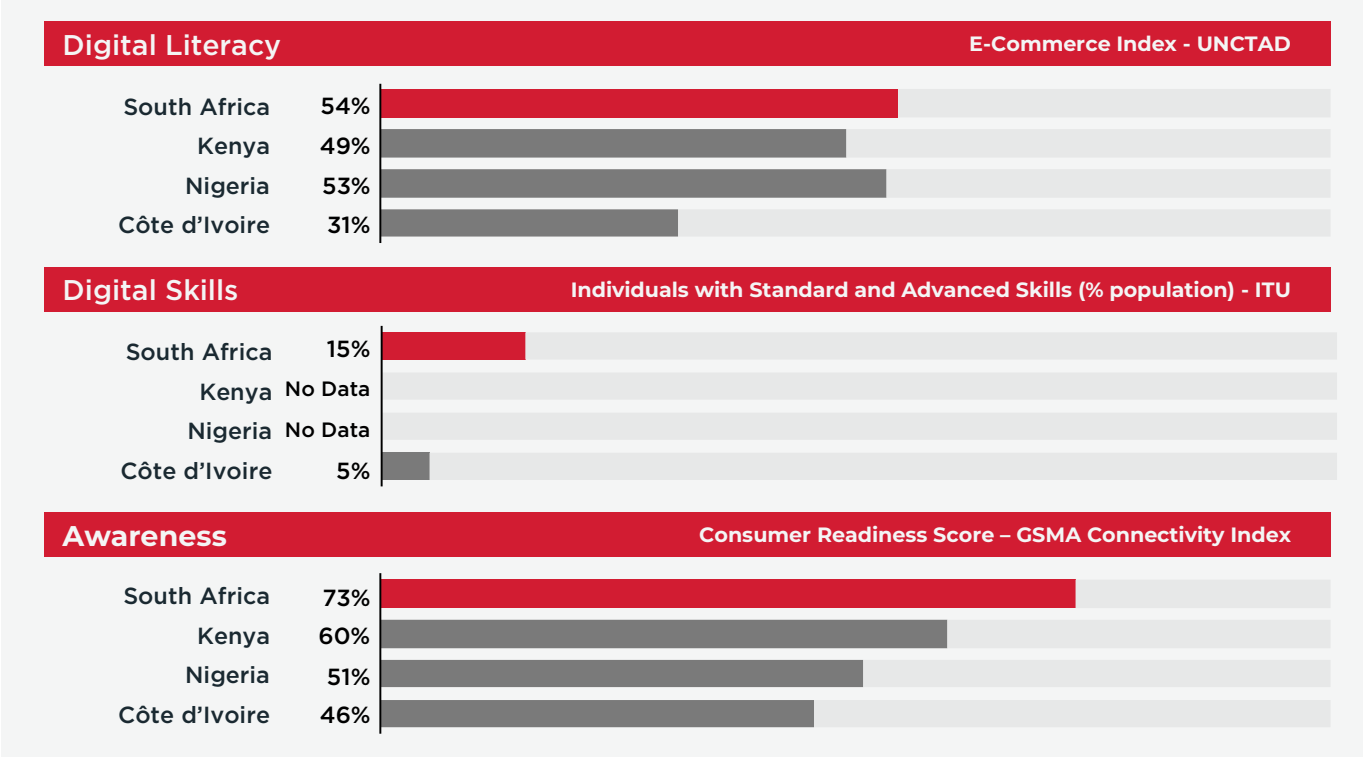
Return to Table of Contents

Readiness Theme 3
Literacy, Skills & Awareness

| While levels of digital literacy are climbing, there are significant shortages in technical digital skills like programming and animation. |

The growth of mobile social media usage suggests a general improvement in the population's foundational digital skills that include digital communication and research tools. These increased levels of online engagement will continue to drive higher levels of trust and competency in digital tools. However, talent migration and the difficulty in obtaining the digital skills necessary to enable XR ecosystems have created a critical labour supply gap. This gap has repeatedly been noted as a pain point for stakeholders, particularly for programmers or animators with three to five years of experience.

Figure 7: Overview of digital literacy, skills and awareness

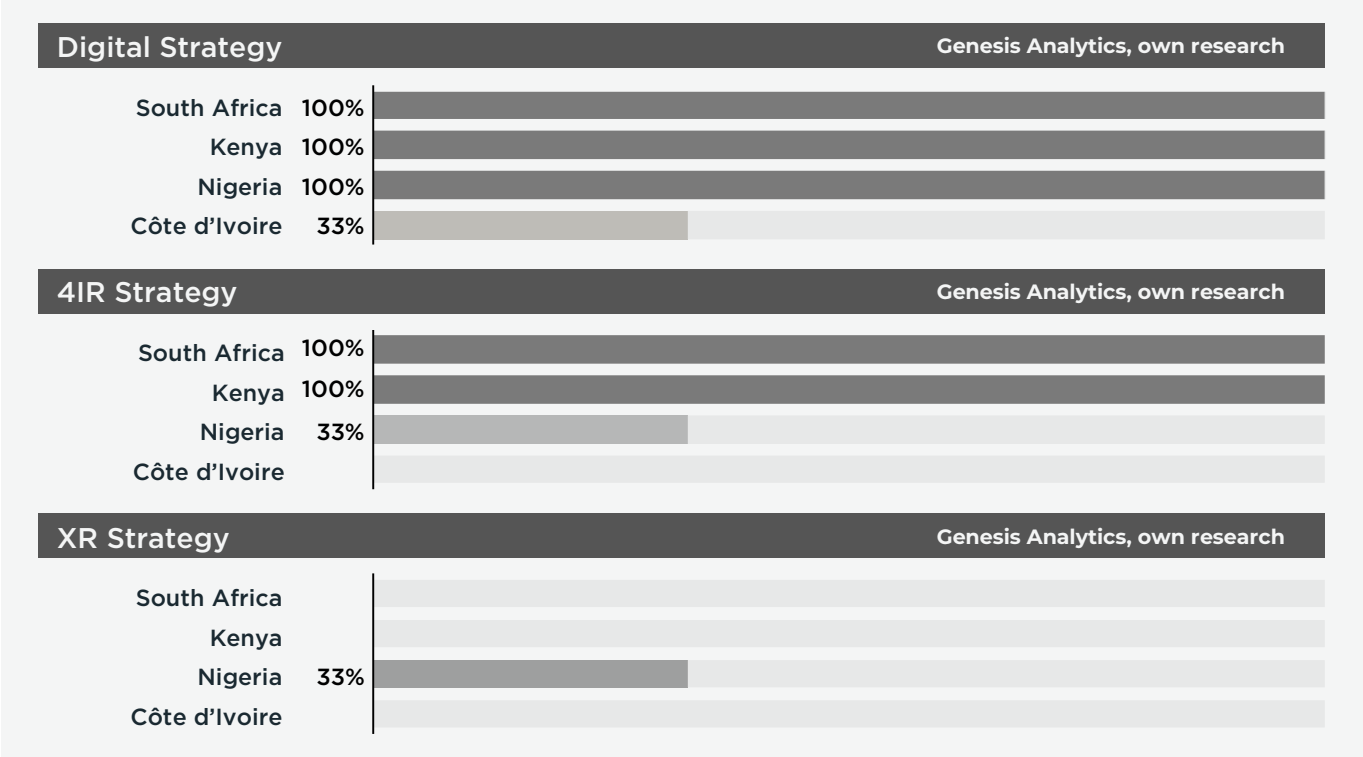


Readiness Theme 4
Strategy & Standards

| Recognising the significance of digital transformation, African governments have set out various strategies, established task forces and are investing in growing the digital economy. |

However, XR technologies are not being prioritised within these strategies and stakeholders note that government stakeholders perceive these technologies as futuristic. Strategy, policy and regulation are particularly sparse in Côte d'Ivoire. While current government engagement in the XR ecosystem is notably absent, stakeholders recognise the importance of government buy-in and the need for strategic agenda-setting to channel these technologies to serve development objectives.

Figure 8: Overview of digital strategy



Rating Criteria:

100 - Has a strategy, is comprehensive and is being acted on;
66 - Has a strategy and is comprehensive;
33 - Has a strategy but is high level, tangentially relevant;
0 - No real strategy or activity

Return to Table of Contents

Scaling XR in Africa

The growth of XR in Africa requires systemic efforts to unlock demand for XR technologies while improving the capacity of supply.

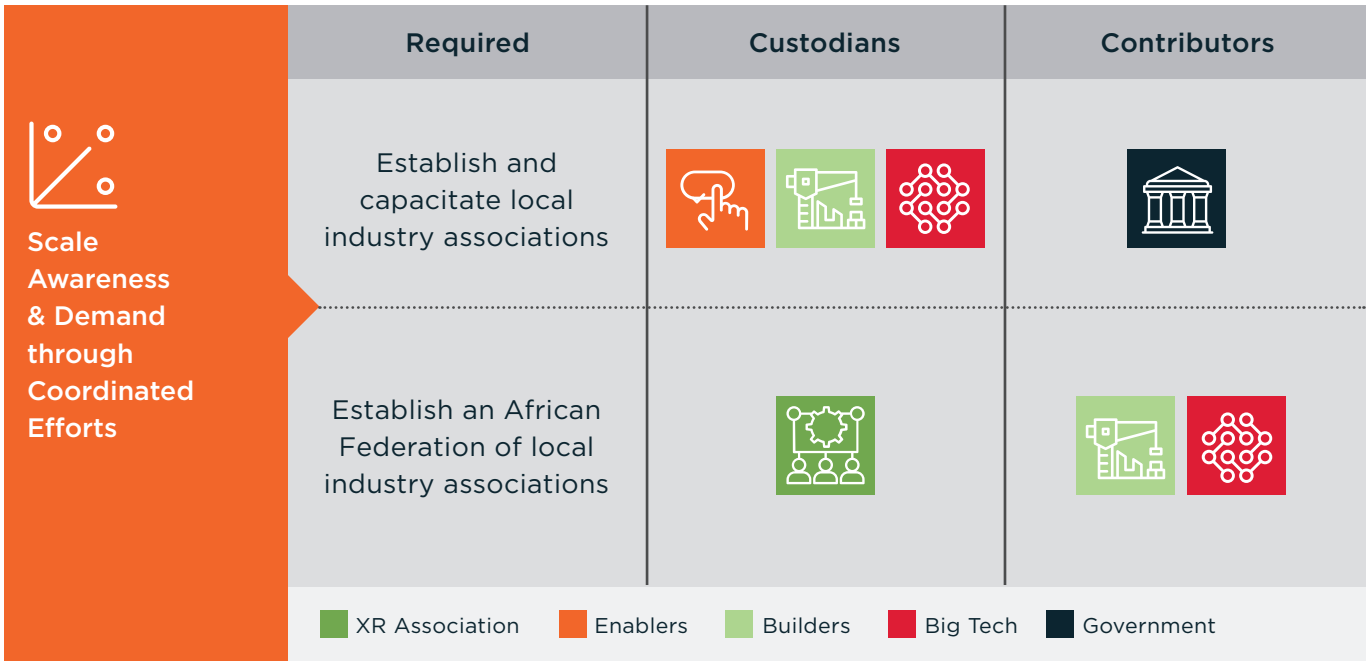
Figure 9 alongside shows the key pillars required to grow the XR ecosystem on the continent, and the priority items within each of these pillars. Actions with a high impact potential within the short and medium term were prioritised. These recommendations are unpacked alongside.

Figure 9: Recommendations for scaling the XR ecosystems

Scale Awareness & Demand through Coordinated Efforts	Spearhead and drive awareness-building campaigns
	Set up and co-ordinate an African XR Summit and Awards
	Help set up and oversee regional and country level XR associations
	Create open source XR tools and resources
Scale Supply through Long-Term Funding	Set up an XR Fund and Accelerator
	Allocate long-term grant funding towards R&D of XR technologies
	Acquire and retain African XR vendors
Grow Africa's Talent Pool	Create and support on-the-job training programmes
	Create comprehensive online XR courses that cater to an African audience
	Create research centres, knowledge hubs, incubators and community hubs
	Enable the uptake of XR development skills through various funding channels and programmes
Improve Access & Affordability of XR Devices	Set up regional distribution and service centres
	Set up the local production of XR devices
	Lobby for the lowering of import tariffs on XR devices
	Introduce payment plans for XR headsets
Co-Create Adaptive Regulatory Frameworks	Making efforts to build self-regulation as an industry
	Address the need for clear spectrum allocation guidelines
	Address and lobby for industry friendly copyright and intellectual property rights

Pillar 1
Scale Awareness & Demand through Coordinated Efforts

Figure 10: Overview of recommendations to scale awareness and demand



One of the recurring themes from the readiness assessment exercise was a lack of awareness regarding the potential impact and range of use cases that XR technologies could provide.

| This has largely hindered the demand for XR technologies. |

Tapping into sources of foreign demand has been critical to the economic success stories of developing countries worldwide over the past fifty years. To truly scale the adoption of this technology and realise the genuine opportunities that they enable, Africa will need to attract international demand. This means dramatically raising the profile of African builders, convening numerous but necessary stakeholders around a joint action plan and monitoring and iterating based on progress.

| The task of creating awareness and bringing in demand is too costly and onerous for any one XR builder to undertake alone, but it is a challenge that impacts every XR builder. |

This work can only be done effectively at scale by a well-capacitated ecosystem facilitator. Industry associations work well when there is a collective challenge facing all industry participants, but where no one industry player can solve it alone.

This work also generally takes place at a local level, but a Pan-African XR Federation should be established to market the continent, create a forum for shared learning, develop collaborative standards and be the custodian of shared resources like an African-centric 3D library and curricula.

Some of the key mandates for a local XR association include:

Drive compacting of a shared action plan for growing the XR sector. This would involve convening necessary stakeholders including builders, big tech, manufacturers, academics, labour, policymakers and regulators to collectively define objectives, targets, timelines and responsibilities for the sector. The association should also act as the custodian and accountability partner for actioning the shared plan, monitoring progress and iterating as required.

Spearhead awareness-building campaigns with a focus on providing first-hand experiences with XR technology while ensuring that experiences are appealing and relevant to the African audience. This would build awareness of the potential applications and impact of XR especially for important stakeholders such as policymakers, corporates, development agencies and business associations.

Local associations can also make efforts to have mass public engagements with the aim of educating the public on XR use cases. Examples of engagement could include holding XR promotional events for the general public, conducting radio and TV interviews as well as releasing media assets such as posters, documentaries and video clips.

Drive foreign demand generation. Given the opportunity for African XR builders to provide services to foreign clients, the XR industry association can provide guidance on acquiring income-generating opportunities in foreign markets. The industry association can play a key role in: i) identifying which foreign markets have the greatest demand for XR builders, ii) representing members at conferences and industry events in these foreign markets and iii) marketing Africa as a credible delivery location for XR services.

Some of the key mandates for a Pan-African XR Federation include:

Set up and co-ordinate an African XR Summit and African XR awards with the intention of bringing together multiple stakeholders in the industry and highlighting industry champions. The summit would also help to highlight and showcase Africa as a global XR destination. By gathering multiple XR stakeholders in one space, the XR Federation can make significant traction on specific industry-wide agenda items that need collaboration and multi-stakeholder engagement. Additionally, there would be an opportunity to further engage with and explore the applications of XR technologies collaboratively.

In addition to the African XR Summit, an African XR Awards Event that is focused on identifying top champions in the XR industry will go a long way in incentivising more builders and enablers to innovate. The Awards can also be an opportunity for XR industry players to meet and explore opportunities for collaboration. The Federation can also support the efforts of existing community-building networks and initiatives such as AR/VR Africa; wearevr; Meta-versations; Africa Comicade; Fak'ugesi, enabling them to have a larger impact.

Facilitate knowledge-sharing across multiple stakeholders. The Federation can play a role in conducting and disseminating research on the XR landscape in Africa. The Federation can also release a yearly African XR report providing updates on sectoral growth and trends. Additionally, there is an opportunity to create more fairness and transparency in the industry by creating, releasing and disseminating industry market standards in Africa e.g., how much should companies pay for services and how long certain tasks or projects should take.

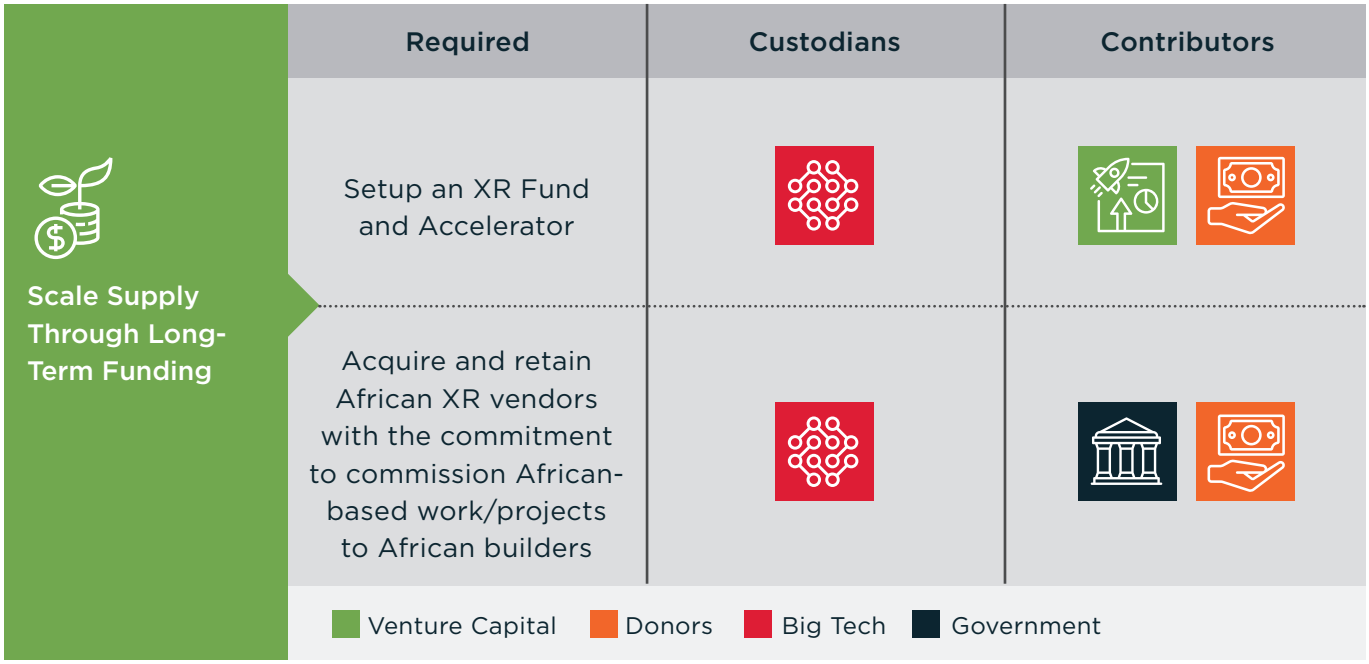
Some of the key mandates for a Pan-African XR Federation include (continued):

> **Create open-source XR tools and resources.** Given that XR technologies are still in the early stages of adoption and development in Africa, there is a clear need for crystallising the fragmented knowledge across different stakeholders through open-source tools and resources. The XR association can play a significant role in shaping and building open-source platforms. Examples of open-source projects that could have a significant impact include: *Creating a commons library* where all XR-related research and information sits. Having a repository for 3D models to enable ease of building XR environments. *Having open-source developer resources and tools* that make it easy to learn, collaborate and troubleshoot. Having free online educational resources that can enable self-learning, upskilling and reskilling. *Creating an extensive Africa XR database* highlighting all key players and stakeholders within the ecosystem and ways one could reach them.

Given the wide mandate that the XR Federation and local industry associations can carry, XR industry players would also need to make clear agreements and commitments to resource and capacitate these bodies sustainably.

Pillar 2
Scale Supply through Long-Term Funding

Figure 11: Overview of recommendations to scale supply



Embedded in poor awareness and a lack of demand is the difficulty in sustaining commercial operations. In such a nascent space where test, fail and learn approaches are expected, conditional grants with and short-term funding constrain innovation. Scaling the sector will require that businesses run on a commercial basis and not be reliant on donor funding.

| To kick-start these businesses, long-term funding, incubation and acceleration programmes are required. |

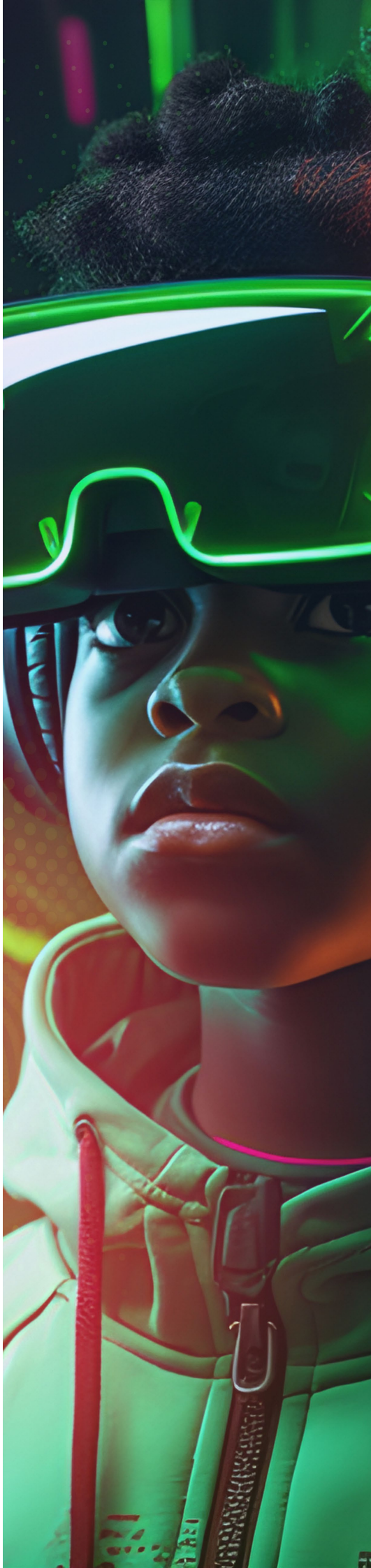
Two key action items are suggested to scale the supply of commercially viable African XR businesses:

Set up an XR fund and accelerator focused on making long-term equity investments in promising XR start-ups. The XR fund can catalyse investment by making initial investments in XR builders to crowd in existing venture capital funds - particularly those that focus on web3 investments (i.e., cryptocurrencies, blockchain technologies and non-fungible tokens). Considering that most XR businesses have been geared towards project-based opportunities, there is an opportunity to support start-ups in pivoting into highly scalable and profitable business models. The XR fund should therefore also allocate resources towards business acceleration support, which can include mentorship, business coaching, access to a network of potential investors and clients and sourcing talent.

| Providing long-term grant funding for frequent hackathons and exploratory projects would also be instrumental in furthering innovation. |

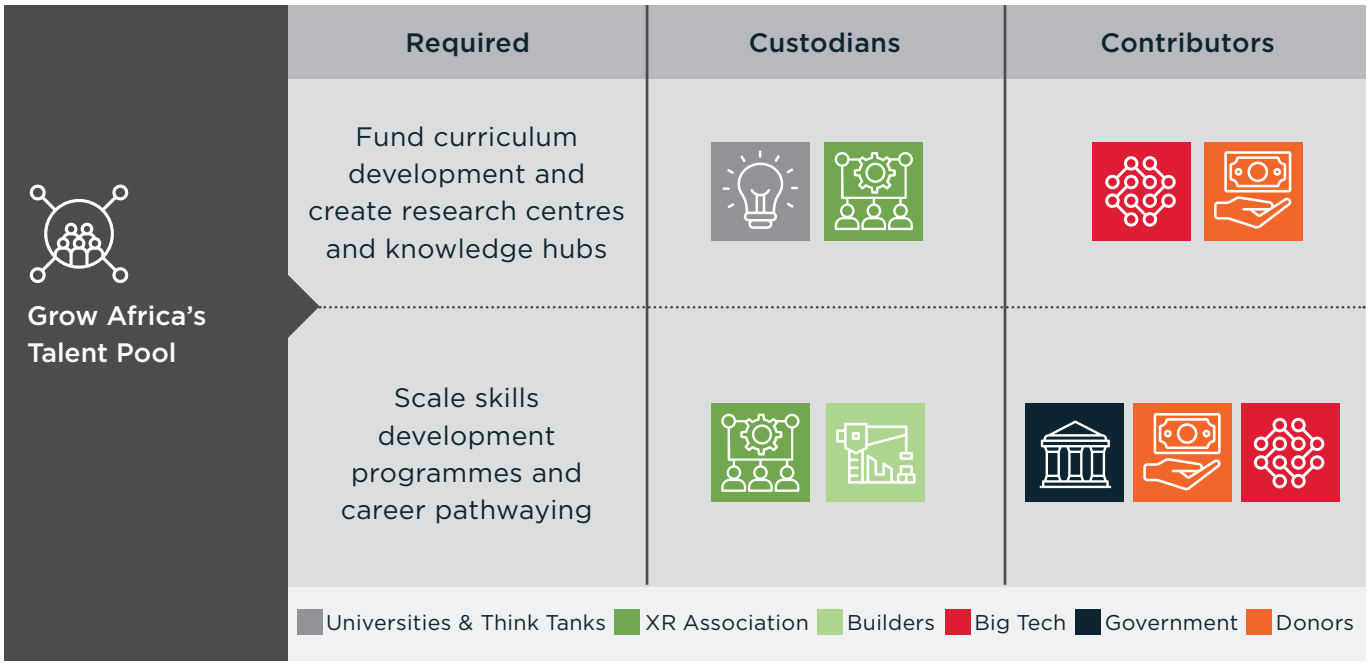
Such collaborative events and projects help connect and unify fragmented knowledge that could spark the discovery of new XR tools and applications in Africa.

Acquire and retain African XR vendors with the commitment to commission African-based work/projects to African builders. As home markets mature, African XR builders are looking to service clients with larger budgets and immediate use cases in advanced economies. A commitment to commissioning African XR builders, especially for African-based projects, would go a long way to enabling the African ecosystem. To solidify and honour this commitment, organisations ought to commit to declaring their budget allocation for African builders. This will build awareness of the commercial opportunity that XR technologies provide while also generating more demand for XR applications. International organisations, local corporates as well as governments should especially be at the forefront of these efforts to spark local innovation.



Pillar 3
Grow Africa's Talent Pool

Figure 12: Overview of recommendations to grow the talent pool in Africa



The readiness assessment revealed that the XR talent marketplace has low levels of intermediate and advanced XR skills. Additionally, the nascent and evolving nature of XR technologies in Africa has made it difficult to rapidly increase the supply of XR skills.

Skills interventions, therefore, need to focus heavily on supply-side initiatives such as:

Create comprehensive XR courses that cater to an African audience. There are pockets of formal research and training that could be scaled. Curricula would need to be iterated as the ecosystem and technology continue to evolve. Beyond traditional learning spaces, online courses and micro-credentials should be supported. This would enable easy and affordable access to upskilling and reskilling on XR. An example of a digital skills platform[37] that focused on an African audience is a future skills-based platform in South Africa and built by Edcast.[38] However, recognition of these online qualifications often falls short of traditional institutions and therefore investments in accreditation and standards need to be explored.

Enable the uptake of XR development skills through various funding channels and programmes such as science, technology, engineering and mathematics (STEM) student loan funds, larger budget allocation aligned with the fourth industrial revolution (4IR) skilling strategies, larger endowments for digital skills and initiating public-private partnerships that can help scale affordable education solutions for consumers.

Partnerships between educational institutions, businesses and the government to **create research centres and knowledge hubs as well as community networks** can drive XR skill building. This would also increase the demand for XR technologies as there would be a need to equip these learning centres with XR devices to drive experiential learning.

Scaling skills development programmes is critical but this needs to go hand-in-hand with career pathways. There are apparent skills gaps that need to be plugged but without the right support to connect trained talent to income-earning opportunities the core challenge is not addressed.

| On-the-job training programmes such as internships and apprenticeships are one way to address this. |

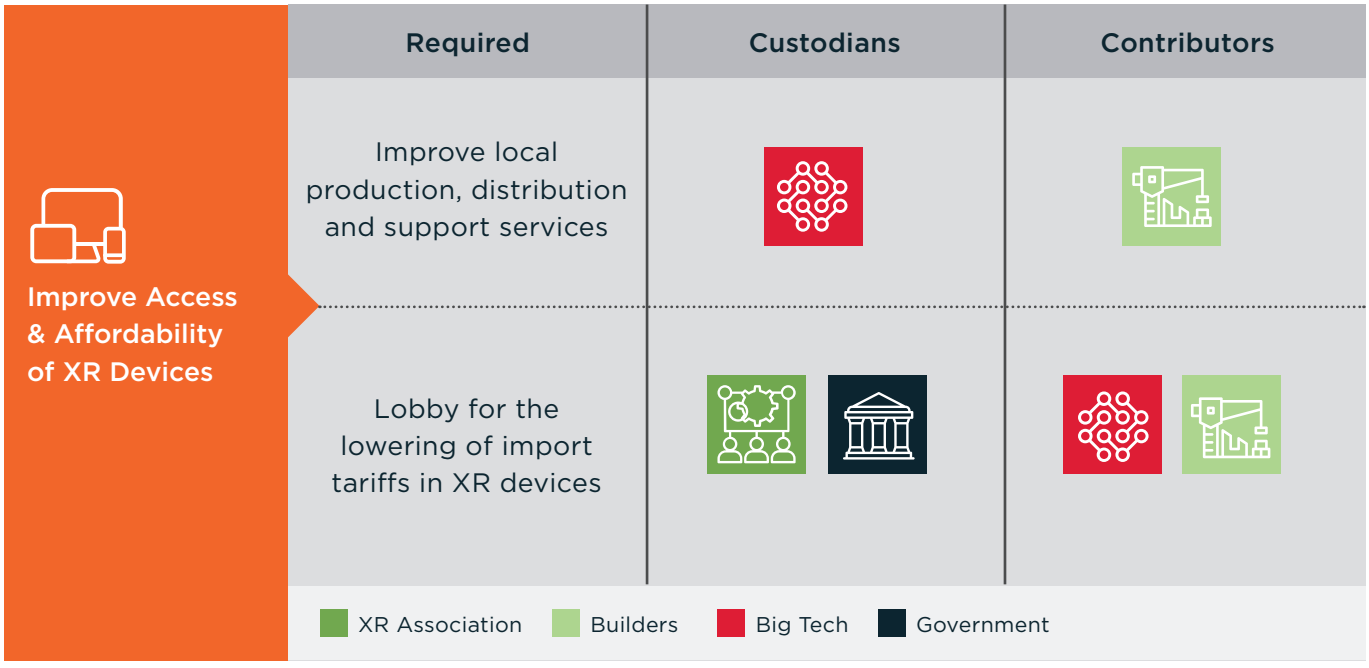
As a highly experiential technology, XR is best suited for experiential environments especially when it comes to learning how to build it. A lot of resources are required to equip fresh talent with XR-building skills. Additional support (both financial and technical) that is provided to expand industry players' capacity to facilitate on-the-job training would enable significant growth for the XR talent pool.

| Another redress mechanism is to work with industry associations and ecosystem enablers to link skills supply and demand. |

Industry associations could create and own digital platforms and online job marketplaces that connect fresh talent with builders in need of skills. Associations should work as an intermediary between XR builders on the demand-side and universities on the supply side to ensure that skilling and curricula design are responsive to industry needs.

Pillar 4
Improve Access & Affordability of XR Devices

Figure 13: Overview of recommendations to improve access and affordability



One of the key supply constraints that emerged from the readiness assessment was the limited access to XR devices. These devices also become unaffordable as a result of high import tariffs and shipping costs.

To address these issues the following action points can be taken:

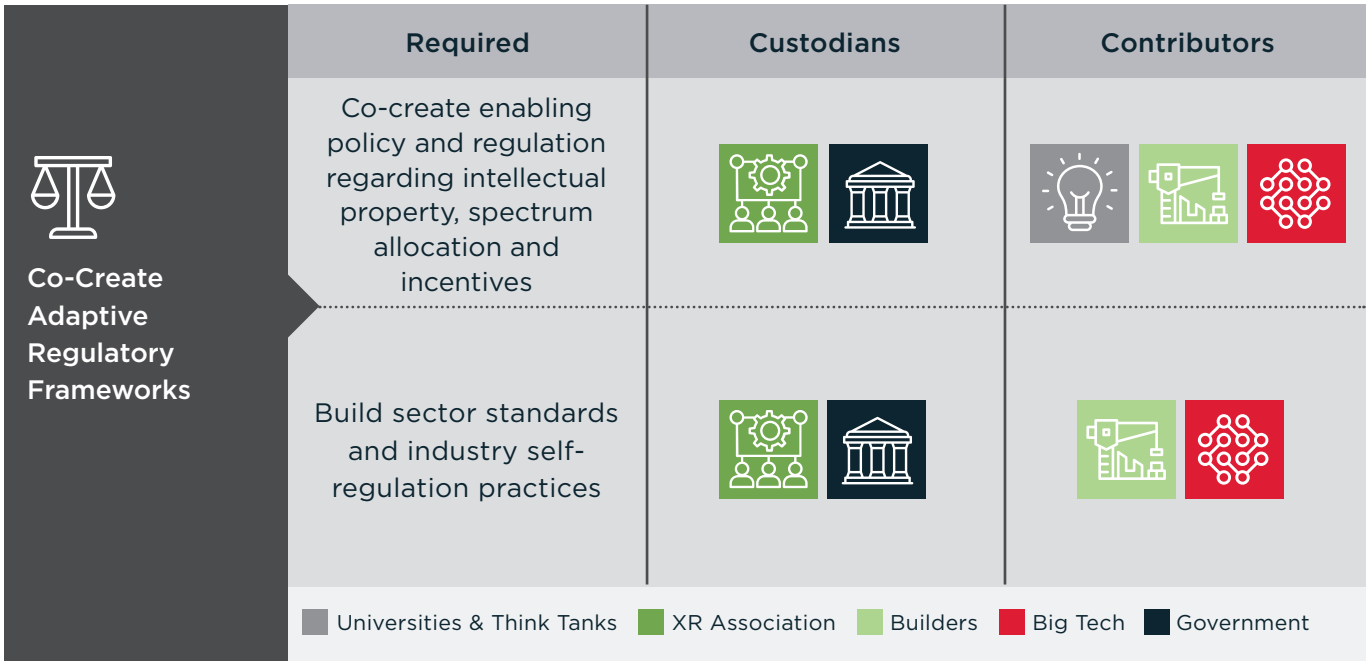
Improve local production, distribution and support services: Set up regional distribution and service centres for XR devices to improve accessibility and affordability. This will also enable easier repair, refurbishment, recycling and reuse of XR devices. The local presence of such service centres can also play the role of creating awareness of the availability of the technology and its potential use cases. The introduction of payment plans for XR headsets can also improve device affordability. Considering that XR devices across Africa cost ~50% of the average user's monthly salary, the issue of affordability could still remain an issue even after implementing the above action points. There is therefore an opportunity to meet and even generate demand for XR devices by enabling payment plans in the African market. It would also be important to consider salary cycles across the different countries/regions when implementing this.

Support for local production of XR devices should also be considered. This can be done by providing support and investment to already existing local producers such as Eden[39] (South Africa) and other potential producers who have the capacity to make XR devices e.g., local smartphone producers such as Mara Phones (Rwanda),[40] Afrione (Nigeria)[41] and Imose Mobile (Nigeria).[42] By increasing the XR device production capacity on the continent, suppliers will then be able to meet the current demand, with the relevant modifications needed for an African user in mind. Alternatively, international producers can directly invest in local production centres.

Lowering of import tariffs on XR devices. While efforts are being made to ramp up local production, high import duties and taxes would still affect the affordability of imported devices. Lowering these import tariffs would still have a significant impact on XR device accessibility in the short term. Where possible, lowering shipping costs associated with importing XR devices would also make a notable difference in improving the affordability of the devices.

Pillar 5
Co-Create Adaptive Regulatory Frameworks

Figure 14: Overview of recommendations to co-create adaptive regulatory frameworks



The fact that most African governments haven't explicitly created strategies and policy guidelines for XR technology can be an opportunity for the XR industry to co-create policy and regulatory frameworks along with policymakers. Beyond that, the industry should also work at self-regulating. Being at the forefront of the sector innovation, the industry will always know best the emerging opportunities and risks that need to be addressed.

Co-create enabling policy and regulation: Create incentive schemes that would foster the XR industry's growth. It's especially timely that there are policy frameworks such as the Start-up Bill in Nigeria which recognise the importance of incentivising start-ups and investors. One of the key incentive schemes could be aimed at encouraging investors to commit long-term funding to XR builders and enablers. This could mean giving investors tax breaks, providing assurance that investors can recoup and withdraw their investments as well as providing stable macroeconomic conditions that attract investors. Additionally, given the current XR skills gap, there would be a case for having XR included in overarching skills development incentives schemes.

| Address and lobby for industry-friendly copyright and intellectual property rights especially in jurisdictions that have had a history of protection of other forms of media such as music and film. |

A lot of the existing copyright and intellectual property laws across the continent do not take into account the nature of software products and are mostly prohibitive, requiring software users to seek permission for copy rights whenever they duplicate any type of software. This constrains the XR technology industry, especially in jurisdictions such as South Africa where such laws are proactively enforced.

Return to Table of Contents

| Address the need for clear spectrum allocation guidelines that would support fast, reliable and affordable mobile/broadband connectivity. |

Spectrum constraints increase the cost structure of mobile operators and trap capital in inefficient capacity upgrades.

In this light, spectrum authorities should work to:

Ensure an abundant supply of spectrum is available. An abundance of spectrum will reduce service provider barriers to entry and increase competition and innovation. Spectrum authorities should identify additional spectrum to be made available in low (sub 1 GHz), mid (1 - 6 GHz), and high (7 GHz and above) frequency bands to support a wide range of broadband use cases.[43]

Promote flexible use. It will take a mix of technical solutions to reach the world's unconnected. Authorities should also support the use of sharing technologies to allow non-interfering spectrum sharing among users with a goal of significantly increasing the spectrum available for broadband.

Balance licensed and licensed-exempt spectrum. Spectrum policy should support both licensed and unlicensed allocations. Licensed spectrum can promote the build-out of large and densely populated areas and lead to economies of scale for chipsets and devices. Licence-exempt spectrum drives innovation and investment which can help meet the latency and power requirements for immersive applications such as AR/VR. It can also support networks and expand broadband access at a low cost.

Promote the capacity and coverage of networks. Spectrum authorities should pursue policies that not only enhance the capacity of networks but also expand their coverage to underserved areas and populations.

Making efforts to build self-regulation as an industry. This would involve being aware and flagging any potential risks that arise from the use of XR technologies, especially when the uptake of the technologies increases. Some of the risk areas that the industry could start exploring include having data privacy and protection standards, addressing issues around product liability and creating guidelines for XR device usage for minors. By anticipating regulation and sensitising policymakers beforehand, the XR industry can mitigate regulatory risks. On the other hand, regulators can actively engage with industry players to understand emerging risks and initiate conversations on the best regulatory approaches that can be used to address these risks.

Appendix 1

Comprehensive Readiness Assessment

Readiness Theme 1
Robust Ecosystem

XR Market

| There are varying estimates on the size of the XR market in Africa, but it is nascent by international comparison. |

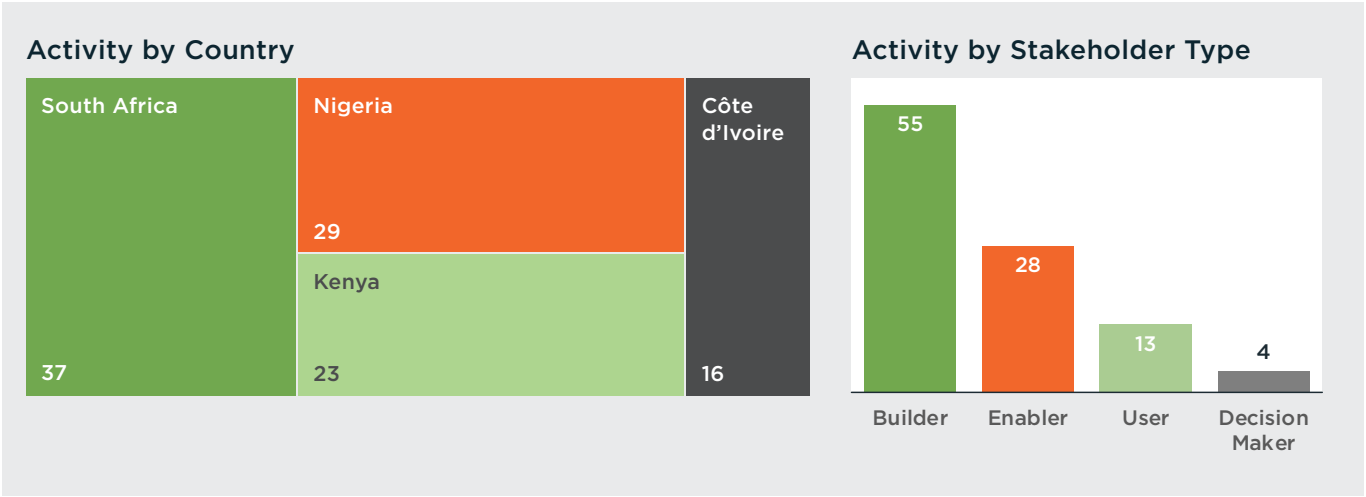
Estimates of the value of the global XR market range from USD 27.96 billion[44] to USD 42.86 billion[45] for 2021 and are projected to grow upward of USD 100 billion[46] before 2030. This represents a significant market with extraordinary growth - while compound annual growth rates for XR range in excess of 30%;[47] growth rates for the IT industry are rarely above 15%.[48] According to a study by the Analysis Group,[49] sub-Saharan Africa would account for approximately 1.3% of the global growth in the Metaverse.[50]

| Despite a small global market share, there is a burgeoning African XR ecosystem, particularly in South Africa, Kenya and Nigeria. |

XR has a longer history on the continent than imagined. The Boiler Room in South Africa has been delivering visual learning products since 1999 and with one of the world's largest 3D libraries they have been servicing major global companies like Anglo American, Sandvik, Unilever and Total.

Other notable African pioneers like Black Rhino VR in Kenya and Imisi3D in Nigeria have been around for nearly a decade. Over 50 different companies[51] building XR solutions are found across South Africa, Kenya, Nigeria and Côte d'Ivoire.

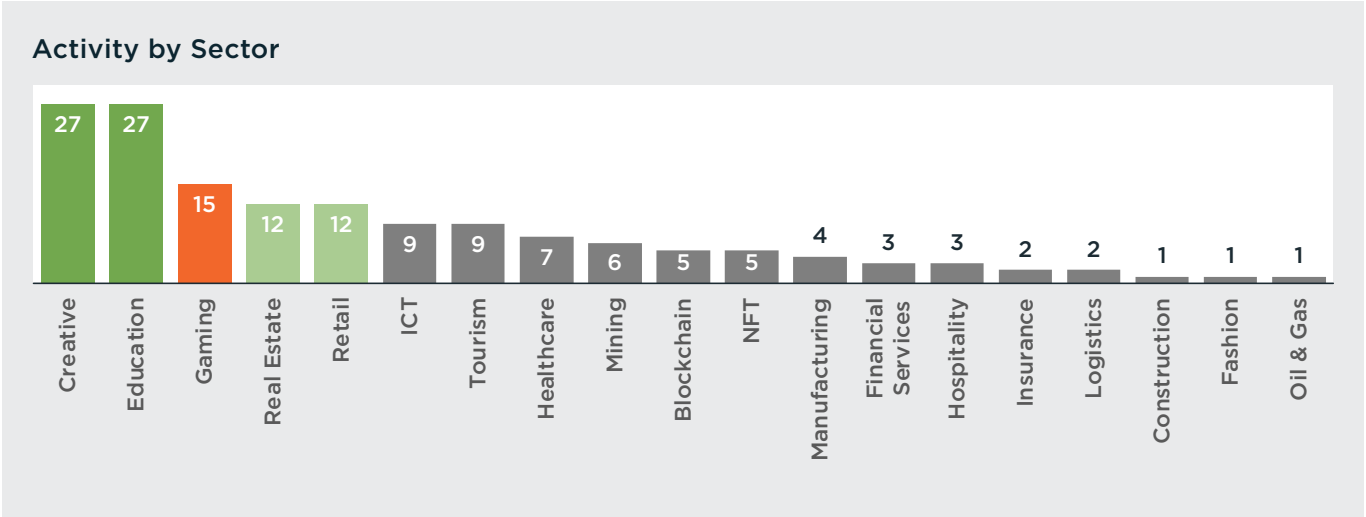
Figure I: The African XR ecosystem



| Most of these builders are concentrated in the creative and education sectors, with gaming, retail, real estate and tourism sectors following. |

There are also some interesting market nuances. While South Africa dominates the heavy industries and financial services, Nigeria has a greater hospitality, NFT and blockchain presence.

Figure II: XR activity by sector



| Awareness and increased interest across the continent are supported by various initiatives and associations. |

Interviews with a number of ecosystem stakeholders have demonstrated strong levels of engagement in this space, with a number of interviewees noting that XR events were often filled within a few days with little to no marketing. These events are critical for generating interest and awareness. The Fak'ugesi Festival[52] is an annual event that showcases the power of combining African culture, art and technology and has been supporting the growth of African digital innovation since 2014. In 2021, the festival saw almost 700 creatives coalesce to discuss the XR market, NFTS, regulation and funding.

AR/VR Africa[53] hosted the 2022 AR/VR Africa Metathon which comprised three major events: online training to help participants learn how to build real-world applications using XR technologies; a hackathon focused on creating innovative XR solutions and a three-month boot camp programme for the winners of the hackathon to accelerate their idea to a prototype. In their 2020 Hackathon, the AR/VR Africa saw over 1000 participants from 28 different African countries take part.[54]

The 2020 Hackathon winner in Kenya – Team Hewa – created an AR solution that assesses and then visualises the amount of air pollution based on the user's location and provides health tips.[55]

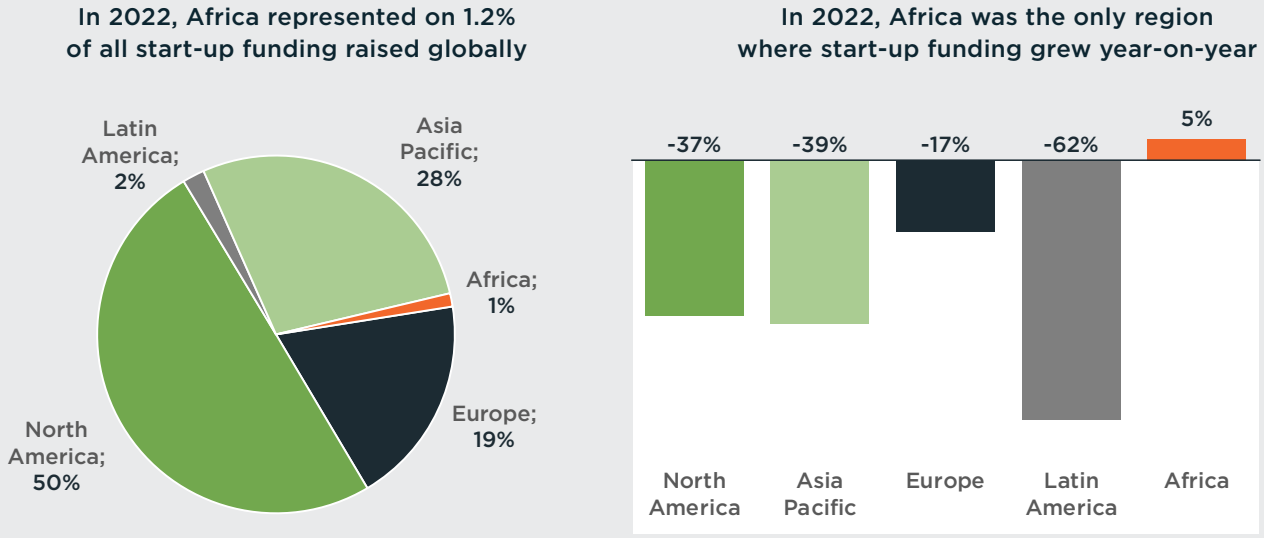
| Beyond events, there are a number of community-building platforms and accelerators operating across the continent. |

For example, Africa Comicade[56] is a platform for digital creatives, working on connecting creatives with job opportunities and the skills needed to build sustainable businesses. Orange Digital Centre[57] which operates across 16 countries, mainly in West Africa, has an accelerator programme as well as an investment fund supporting and financing innovative start-ups. The Orange Digital Centre in Côte d'Ivoire has hosted over 40 events and training sessions.[58] Another prominent example is 3D Net-Info in Tunisia. Launched in 1999, 3D Net-Info is the first French-speaking African school to specialise in coding, animation and XR. More recently, 3D Net-Info launched its incubator programme in collaboration with Digihub which aims to support students to migrate innovative projects to sustainable businesses.

| There are three key constraints on the ecosystem that require attention and investment: funding gaps; poor awareness and affordability. |

The relative levels of funding constrain the growth of digital economies across the continent. Organisation for Economic Co-operation and Development (OECD) data shows that while the amount invested into start-ups in the US in 2019 exceeds USD 135 billion, South Africa saw around a third of a percent of that, at USD 481 million.[59] By the end of Q3 in 2022, Africa has seen investments in all start-ups of just over USD 4 billion.[60] For comparison, a single US-based XR company - Magic Leap - has been able to raise USD 3.5 billion since its founding in 2010.[61] The type of funding, along with the overall levels of funding, is important. In such a nascent industry, funding tied to strict conditions or concrete parameters can constrain fail-fast methods that are foundational to successful innovation.

Figure III: Funding raised by start-ups in 2021 & 2022 – by continent



Source: Africa: The Big Deal

| The overall sentiment from stakeholders interviewed is that there is a lack of African demand for XR applications. |

A number of interviewees highlighted that most of the demand for their products, services and even demand for talent originates from North America and the Middle East. Africa Comicade has seen the vast majority of its developers contracted by companies based in Dubai. Similarly, Mathew Munyao - an NFT creative - sees most of his work acquired by North Americans. Companies that have been in the industry for some time have large international clients rather than regional or local firms. Leti Arts, which has been operating in the gaming industry since 2009 notes that almost all their revenue comes from consulting projects for international donors like USAID, GIZ and large corporates like Microsoft, Google and Intel. The Boiler Room also feeds its 90-strong staff with contracts with blue-chip companies like Anglo American, Exxaro, IBM and Siemens.

| The lack of demand is driven primarily by poor awareness and a lack of affordability. |

Many stakeholders interviewed raised that this technology is viewed by consumers, firms and governments as a futuristic technology, nice-to-have, or serves purely entertainment purposes. This perception erodes the willingness to pay for these applications. Changing these perceptions and bringing greater awareness to the power of these technologies require intermediaries - advocates and marketers, publishers and associations. Building out the network of intermediaries has been a central focus of the Fak'ugesi initiative in recent years after understanding from creatives that this is a critical barrier to scaling and building sustainable businesses. Clear business and use cases need to be communicated.

| Broadly, there is a promising supply-side story on the continent with some compelling innovators and use cases that are already contributing to the identified headline opportunities. However, limited awareness and marginal levels of funding to stimulate the ecosystem constrain the growth trajectory of XR on the continent. |

Readiness Theme 2
Universal Digital Access

Connectivity

| Connectivity is the bedrock of internet applications, including AR and VR technologies. |

Connectivity exists both in a fixed broadband and mobile environment. While mobile connectivity has been Africa's primary gateway into the digital economy, higher quality and more immersive experiences will depend on high-speed Wi-Fi and fibre connections. Key players in the industry have highlighted the importance of good quality, immersive AR/VR experiences to facilitate interest and uptake of this new technology. Connectivity requirements will depend on the use case which is illustrated below.

Figure IV: Static and Mobile Connectivity for facilitating AR/VR

Static: *Wireless Local Area Networks (WLANs), like Wi-Fi, usually provide higher internet speeds but limit mobility of the tech.*

Basic AR generally functions well on around a **20Mbps** internet speed for 3D models and data visualisation purposes. → VR internet speed requirements vary depending on the level of immersion for speeds of around **50 Mbps** for basic immersion to **2-5Gbps** for full immersion.

Mobile: *WWAN (Wireless Wide Area Network) are required for mobile XR usage. This comes in the form of 2G, 3G, 4G LTA, and 5G.*

3G connection is sufficient for many AR applications. → Immersive VR experiences require higher levels of connectivity, with **even 5G not always being sufficient** for deeply immersive experiences.

Source: Genesis Analytics

| Looking first at mobile connectivity, coverage has rapidly improved across the continent, yet affordability and speed remain low. |

In 2019, 3G coverage in Africa expanded to 75% compared to 63% in 2017 and based on the GSMA Mobile Connectivity Index, levels of 2G and 3G coverage are high across all four countries. Despite these high levels of coverage, network performance, consisting of upload speed, download speed and latencies, are still low.

| Currently, the only country that has active 5G networks is South Africa. |

However, 5G is currently being launched in Kenya and Nigeria and Côte d'Ivoire has plans to launch 5G in 2023. 5G offers the possibility for higher speed internet that is accessible to people who don't have access to static connectivity - fixed broadband and Wi-Fi.

Return to Table of Contents

| Broadband usage in all four countries in this study is low. |

Due to the infrastructure-heavy nature of wired internet, it is likely to continue to be less available in rural areas. Thus, improving mobile connectivity and expanding fixed wireless access will be important to enabling AR, and VR technologies in these geographies in the future.

Table I: Overview of Internet penetration across the four target countries

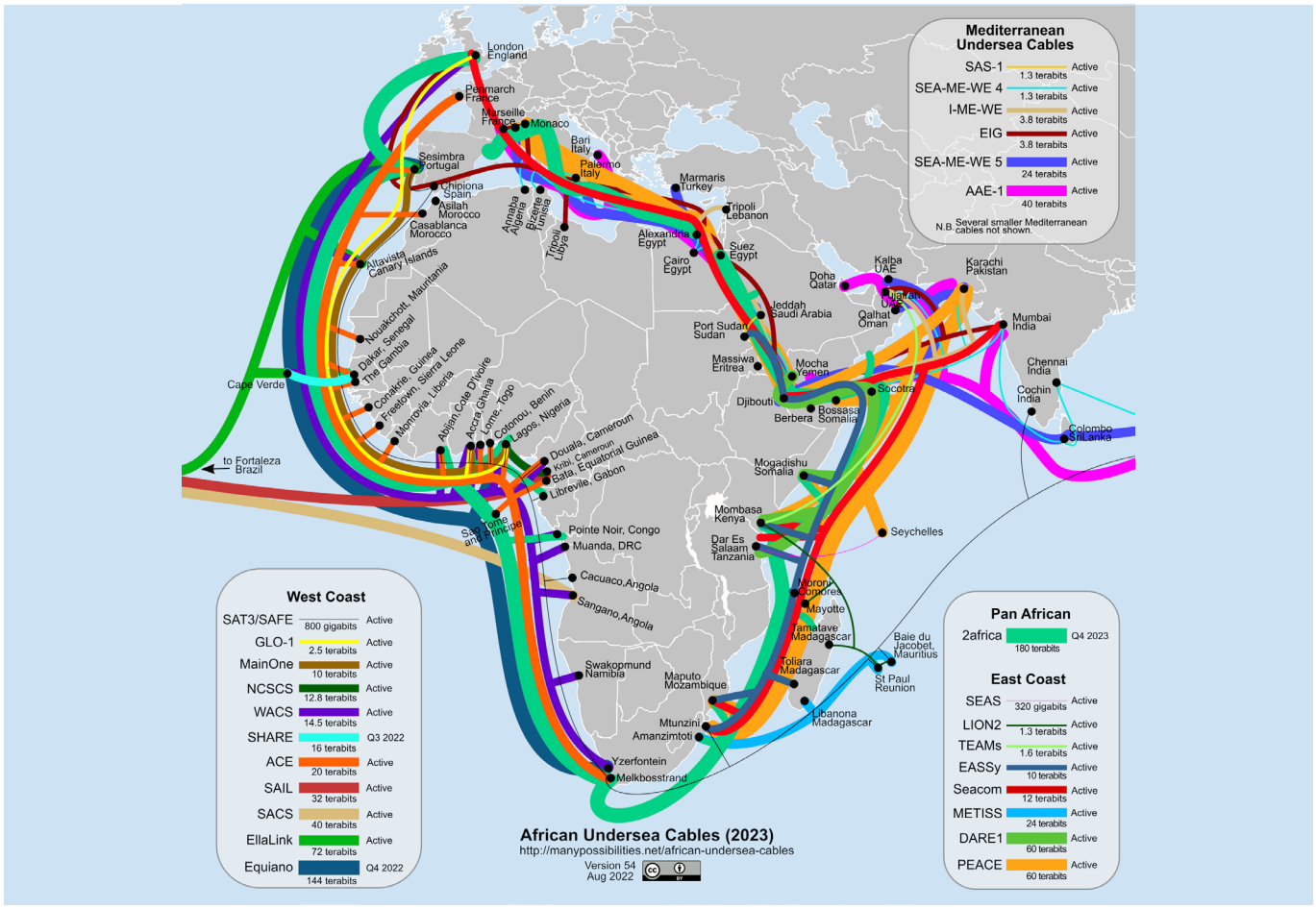
Internet Coverage Metrics	South Africa	Kenya	Nigeria	Côte d'Ivoire
2G Coverage (%)	100	96.3	90.8	97.6
3G Coverage (%)	99.5	97.9	82.4	92.5
4G Coverage (%)	99	96.3	70.6	57.9
5G Coverage (%)	13.7	0	0	0
Fibre Coverage (%)*[62]	51	32	28	21

Source: GSMA Mobile Connectivity Index

| Notable investments are being made to improve connectivity across the continent and the future for connectivity in Africa looks promising. |

The 2Africa undersea cable is a significant global investment being made by Meta and its partners. This infrastructure aims to improve internet connectivity between Europe, Africa and the Middle East. This project is expected to go live in 2023/2024. The figure below summarises undersea cable investments to service the continent.

Figure V: Africa undersea cables



Wi-Fi 7 will be the next major evolution in wireless internet. Increased network speed and reduced latency will enable Wi-Fi innovations, enhanced cloud computing and video streaming and improved XR use cases and applications in industrial, educational, healthcare and gaming industries.

Devices

| Africa is a mobile-first continent, with mobile phone subscriptions exceeding population figures in all four focus countries. |

It is predicted that by 2025 there will be 120 million new mobile subscribers, with total subscribers in the region reaching 615 million. While there is a clear separation between people who own smartphones and feature phones, there is a growing trend toward increasing smartphone ownership.[63] The table below looks at the change in ownership between 2015 and 2018. Mobile phones, particularly smartphones, are an important entry point for AR and VR experiences.

Table II: Levels of Ownership and (% Change) Between 2015-2018

Device	South Africa	Kenya	Nigeria	Côte d'Ivoire[64]
Smartphone	60% (+23%)	41% (+15%)	39% (+11%)	28%*
Feature Phone	33% (-19%)	45% (-11%)	44% (-18%)	-

*Source: Pew Research Centre; *Data for Côte d'Ivoire is for 2019 and sourced from the communications regulator; no data is available for feature phone ownership for Côte d'Ivoire.*

| This increased smartphone ownership is significant as it enables the uptake of AR/VR applications which aren't accessible on feature phones. |

Despite the ubiquity of mobile phones, some XR pioneers caution against mobile-first XR development. While mobile-first development seems like a solution in a low-tech environment it poses some notable issues. Mobile applications also constrain the sophistication of the XR application and levels of user immersion which limits the specialised benefits of these technologies.

Table III: Device ownership (% of internet users aged 16-64)[65]

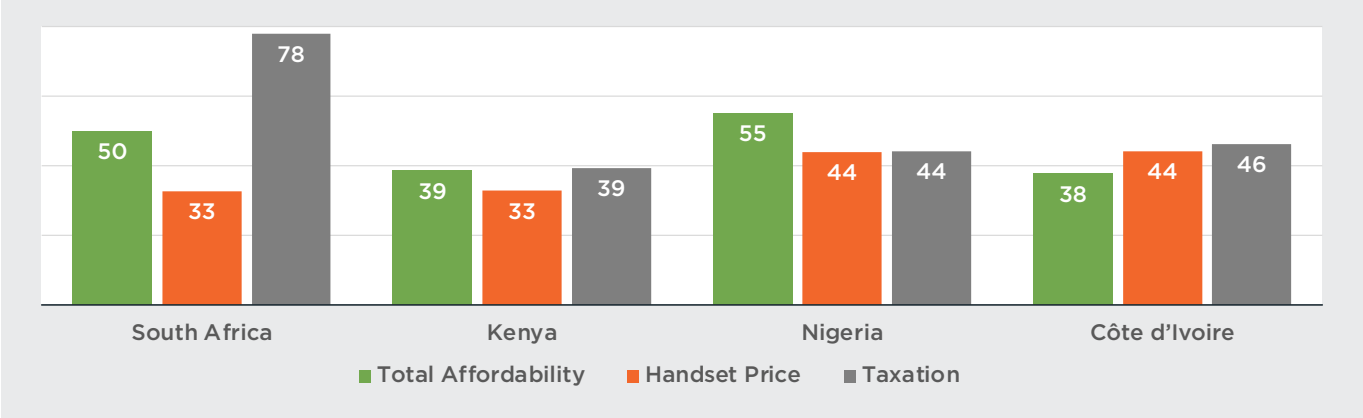
Device	South Africa	Kenya	Nigeria	Côte d'Ivoire*
Mobile Phone	98.2	99.9	99.5	63.62
Smartphone	98	99.7	99.2	-
Non-Smartphone Mobile Phone	11.7	14.4	14.6	-
Laptop/PC	85.4	60.2	54.1	35.73
Tablet Device	43.2	19.9	13.8	0.64
Game Console	30.2	8.4	9.6	0.01
Virtual Reality Device	4.4	1.7	0.9	-

Source: Datareportal Digital 2021 Reports for South Africa, Kenya, Nigeria. Côte d'Ivoire uses the 2022 report.

| Device affordability and accessibility pose a challenge to the adoption of AR/VR in Africa. |

Within the GSMA Mobile Connectivity Index, there is a specific indicator set that looks at device affordability - shown in the figure below. Higher scores represent stronger performance (in this case more affordable). With regard to the overall affordability of mobile connectivity, all countries have low levels of affordability, with Kenya being the lowest.

Figure VI: GSMA Affordability Index and Component Inputs



Source: *Mobile Connectivity Index. Available here.*

| Major suppliers of XR devices, including Oculus, Microsoft, Google, HTC and PlayStation have a small and uneven footprint across the four countries. |

While South Africa has a well-established XR hardware supply chain, and Kenya is catching up, Nigeria and Côte d'Ivoire rely on limited and expensive imports of XR hardware. In a survey conducted by the Africa XR Report, 64.1% and 54.7% of respondents in the XR industry found hardware costs and hardware availability a challenge for their businesses.[66] This impacts affordability and post-purchase support and repairs. Access to specialised devices is repeatedly noted by stakeholders as a critical barrier to scaling this ecosystem. Among creators surveyed in the Africa XR Report, 69% reported cost as a major challenge and 55% raised hardware availability as a barrier.[67]

Table IV: Cost of devices on Amazon (+ import taxes and shipping costs)[68]

Device	South Africa	Kenya	Nigeria	Côte d'Ivoire
Oculus Quest 2 *(Meta headset plus sensors, touch controllers, 3D audio, released 2020)*	$400 (+$95)	$400 (+$200)	$400 (+$250)	$400 (+$300)
% of average monthly salary	23.7%	73%	51%	70.9%
VIVE Pro 2 (Full System) *(HTC headset, location tracker, % of average monthly salary controllers, 3D audio, released 2021)*	$1,100 (+$270)	$1,100 (+$643)	$1,100 (+$340)	-
% of average monthly salary	65.6%	213.3%	112%	-
Ray-Ban Stories *(Meta Ray-Ban, sunglasses, built-in camera, speakers)*	$299 (+$67)	$299 (+$135)	$299 (+$117)	-
% of average monthly salary	17.6%	53.2%	32.5%	-
ROKID AIR *(Portable AR glasses, voice control AI, screen, speakers)*	$428 (+$90)	$428 (+$201)	$429 (+$240)	-
% of average monthly salary	24.8%	77%	52%	-

Source: *Datareportal Digital 2021 Reports for South Africa, Kenya, Nigeria. Côte d'Ivoire uses the 2022 report*

| Some African companies have started to manufacture their own devices to plug the gaps. |

For example, Eden, a South African-based VR company, developed their own VR headset and stations for use in hospitals. This technology provides both entertainment and education for child patients. This technology is still very expensive and is currently only being developed for commercial in-hospital use.

Readiness Theme 3
Literacy, Skills & Awareness

Skills in Demand

| Scaled adoption of XR requires foundational digital skills for users of these technologies and specific skills for builders of XR applications. |

Table V: Overview of digital skills

Foundational Skills	Intermediate Skills	Advanced Skills
Use of XR applications, web research	Digital business management, project management	XR application development

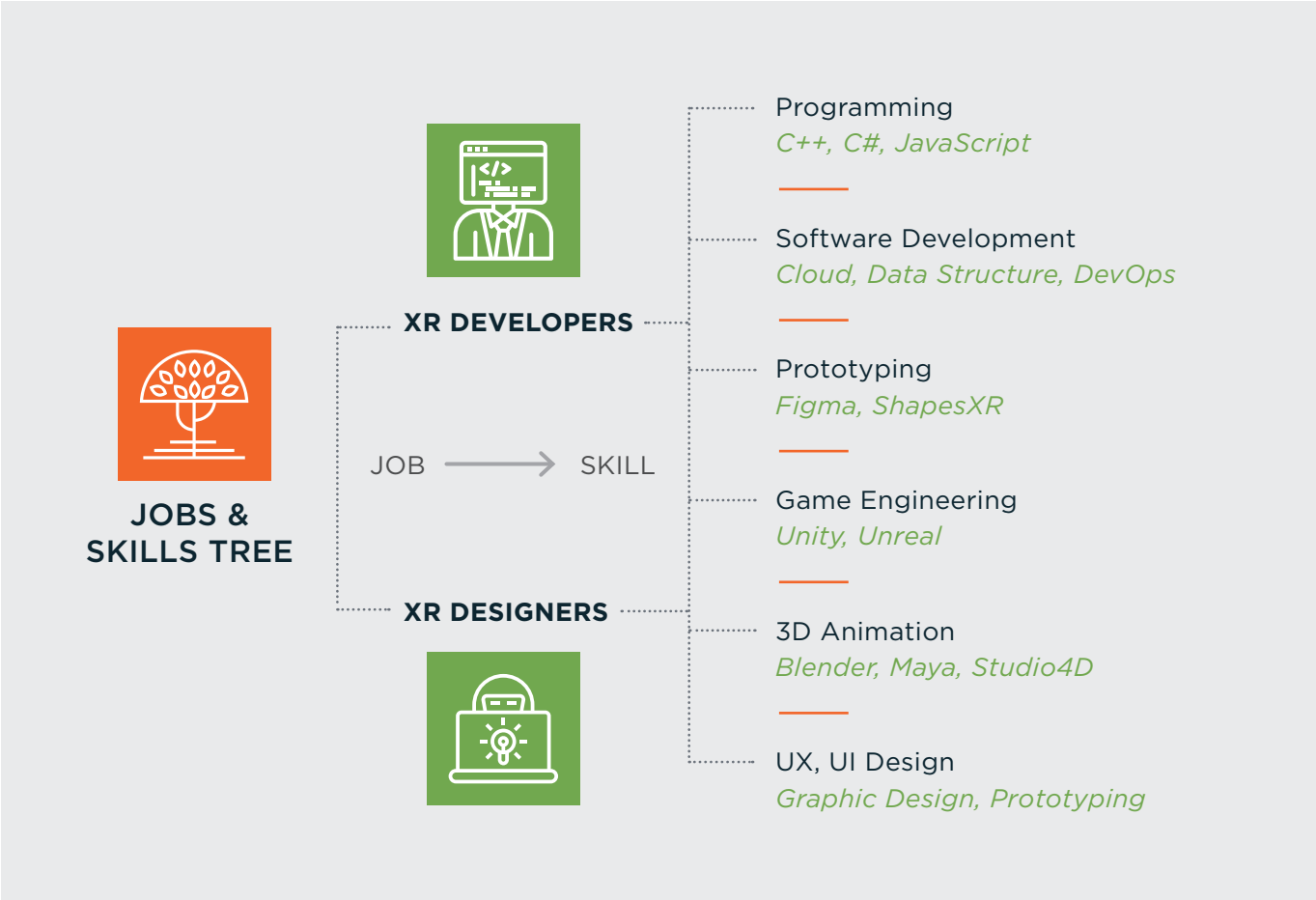
Foundational skills are basic digital literacy that involves the competency to use digital technologies, like XR applications and devices.

Intermediate skills consist of non-ICT competencies to use digital tools for professional or organisational tasks in XR businesses. These skills are important for developing market-specific and commercially viable products:[69]

- Digital product management
- Data analysis
- Digital marketing
- Business communication
- Software development project methods

Finally, **advanced skills** are needed to design and build XR products, services and processes. There are two broad streams of XR sector jobs, each with its own required skill set. XR Designers are the 'architects' of XR worlds and focus on the user experience and interaction with the XR system. XR Developers are the 'builders' of XR worlds, creating the code base and technical functionality of XR systems.

Figure VII: Skills tree of VR jobs[70]



Skills Supply

| Digital literacy is difficult to measure but indicators such as social media penetration and e-commerce activity are useful proxies in a 'mobile-first' context. |

Table VI: Digital literacy across the four countries

Digital Literacy indicators	South Africa	Kenya	Nigeria	Côte d'Ivoire
Mobile Social Media Penetration[71]	45.7	20.9	15.4	23.3
E-Commerce Index (Rank)	54.4 (76)	49 (88)	53.2 (79)	31.3 (118)

| Social media adoption is relatively low but growing rapidly across the continent. |

More than doubling in South Africa and Nigeria between 2017 and 2021 and increasing by 64% and 42% in Côte d'Ivoire and Kenya respectively. All four countries have improved their year-on-year UNCTAD E-Commerce Index ranking.[72] The increase in e-commerce and digital payments is another means through which digital literacy is demonstrated.

| The increase, and encouraging growth trends, of foundation digital literacy suggest that the market for AR/VR technology users is growing and has a substantial potential user base with expanding digitally-native youth. |

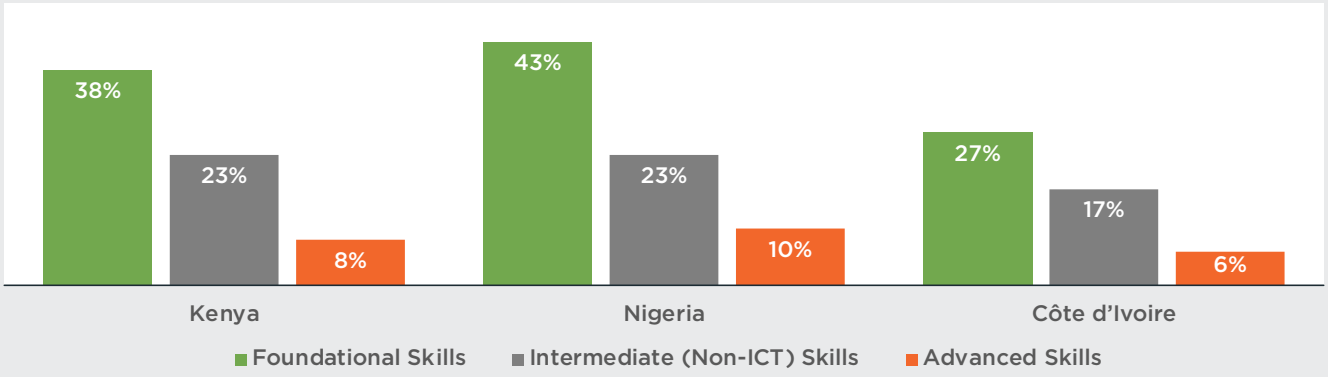
| Educational providers do not currently meet the training demands for developing XR-specific skill sets. |

In a survey conducted by the African XR Report, businesses listed the lack of local XR talent among the top five business challenges, with many companies resorting to the global talent pool outside the continent.[73] While 54% of creators surveyed learn XR skills on-the-job; less than 10% learnt their skills from a tertiary institution, and less than 1% from secondary school.[74] The supply gap of advanced digital skills is limiting countries' ability to become producers and service providers in the digital economy and XR space. With the exception of a number of accredited XR training providers in South Africa, XR training across Africa is limited.

| Cost and access to digital skills training remain a big barrier to upskilling and re-skilling the target countries for AR/VR readiness. |

The following case study of education access in Nigeria, Kenya and Côte d'Ivoire outlines the relative affordability of obtaining different levels of ICT skills. In the figure below, the Y axis refers to the type of skill level by country, while the X axis refers to the percentage of households able to afford digital skills training.[75] The data shows that digital skills training remains relatively exclusive and is a big financial burden for the majority of people in these countries; especially to obtain the advanced skills necessary for technical XR development jobs.

Figure VIII: Household affordability of different levels of digital skills training[76]



| Studies and stakeholder sentiment corroborate that these countries are experiencing a 'brain drain' of top local IT talent. |

Despite the large demand for qualified graduates, the top digital and XR talents produced in these countries often leave the country to work for higher-paying opportunities elsewhere around the world.[77] Talent retention will be key to the growth of the XR ecosystem in these countries as talented ICT experts are in high demand globally.

| Efforts to increase the supply of intermediate and advanced digital skills are necessary to meet the high demand and interest in technical digital competencies. |

In Nigeria, Kenya and Côte d'Ivoire, the demand for digital skills training is estimated to exceed 100 million.[78] This is driven not only by growth in the technology sector but also due to the digitisation of more traditional 'brick and mortar' sectors like retail and tourism that are starting to utilise digital technologies.

| While the skills and competencies required for XR are advanced, university degrees are rarely a prerequisite.[79] |

Tertiary qualifications in computer science or 3D animation signal certain baseline competencies, yet employers are more concerned with specific XR experience and portfolios. This is notable given the lack of affordability of tertiary education and gives relevance to more accessible alternative channels like online or community-based learning.

| Online learning tools have proven an important and widely used means to build XR skills. |

51% of African XR professionals acquired XR skills from online courses.[80] Courses from online training providers like Circuit Stream, XR Bootcamp, Udemy and UnityLearn, provide tailored training for a variety of skill levels and specialisations. The availability of open-source and free resources makes online learning an attractive avenue for generating the necessary pipeline of digital skills.

| Community learning models have also been an important source for training and mentorship for XR enthusiasts in Nigeria and South Africa. |

Online XR communities like the Metaverse Crew use platforms like Discord and WhatsApp to engage, share tools, insights and experiences among XR enthusiasts across Africa. Hackathons like the AR/VR Africa Hackathon introduce and allow participants to build hands-on competencies in XR development and design. These networks are important to build an ecosystem in such a nascent sector.

Figure IX: Educational providers to build XR skills

CONTINENT-WIDE & ONLINE RESOURCES

- XR Bootcamp
- Coursera x UMich - Extended Reality series
- Udemy - Game Engine use tutorials
- IBM Digital Nation Africa
- CISCO Networking Academy
- NIIT
- Andela
- NobleProg
- Knowledge Academy
- Circuit Stream - XR Development and Design Courses

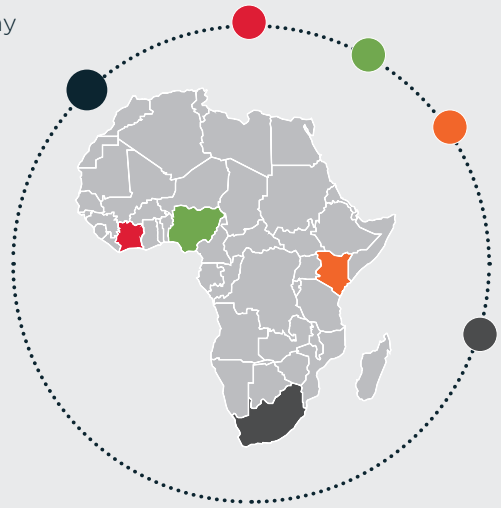
45 000 graduates between 2015 and 2021

- Moringa School

766 graduates in 2019

CÔTE D'IVOIRE

- Ivory Coast Virtual University (Public)
- Institute of Sciences and Communication Techniques (Public)



NIGERIA

- HiiT Plc (Private)
- Anchorsoft Academy (Private)
- Convenant University (Private)
- HOFT Developers (Private)

1000 students enrolled

KENYA

- Computer Pride (Private)
- Kenya Institute of Software Engineering (Public)
- Rift Valley Technical Training Institute (Public)

1100 graduates annually

SOUTH AFRICA

- School of IT (Private)
- CapaCiti (Private)
- IIE Varsity College (Private)
- Umuzi (Private)
- Tshomologong (Private)

62 graduates in 2021

- Public Universities (Public)

64 636 graduates in 2019

Perception & Awareness

| A frequent reservation about XR technologies is that it is a 'nice to have' but non-essential. |

The predominant view is that XR is most applicable in the gaming industry, and not a key business or learning tool. Greater advocacy or awareness of XR use cases can help drive adoption and sector-specific innovation.

| Another concern is that AR/VR is too 'high tech' for a predominantly 'low tech' environment in the targeted African countries. |

There is a sentiment that since these technologies are still in their global infancy, Africa's level of digital development is not suitable for adopting these technologies. This misses the future opportunities of these markets as well as the 'lower tech' uses of mobile AR applications. There are also cases of big corporates, heavy industry, agriculture and healthcare in Africa already utilising XR technologies effectively for training.[81]

| The wearable elements of XR technology, especially VR are considered to have practical constraints and can induce unwanted physical effects. |

VR Headsets are reportedly rather clunky to wear and unsuitable for extended periods of time. In the African context, users have reported discomfort with the head strap not being designed with diverse hair types and styles in mind. Another challenge is VR-induced motion sickness. The sensation of movement that VR simulates while the body remains stationary is widely reported to cause motion sickness symptoms like dizziness and nausea in some users,[82, 83] However, reduced latency, improved frame rates and motion tracking will decrease the intensity and likelihood of motion sickness.[84] There are also concerns about the safety of using VR/AR in public, should users get distracted and not pay attention to their surroundings. Some of these concerns will likely be improved as the technology becomes more mature but it is important that these technologies prioritise user experience, especially accounting for local contexts.

Readiness Theme 4
Strategy & Standards

| Recognising the significance of digital transformation, African governments have set out various strategies, established task forces and are investing in growing the digital economy. |

African governments are currently prioritising human capital development, building solid digital infrastructure and creating institutional as well as regulatory capacity to respond to the fast-changing nature of the digital economy.

Numerous African policymakers already recognise the importance of 4IR technologies, namely data and artificial intelligence and are therefore likely to use artificial intelligence (AI)/data policy frameworks as key reference points when considering other technologies. Most African governments however have not specifically considered XR technologies in their overarching digital strategies.

Seeing that XR technologies are already unlocking great development opportunities, especially in education/skills-building across the continent, there is a need for awareness creation among policymakers. African governments especially need to resonate with the unique requirements and impactful use cases that XR technologies present.

Table VII: XR Policy Landscape Overview

XR Prioritisation	South Africa	Kenya	Nigeria	Côte d'Ivoire
National Development Plan	Not mentioned	Not mentioned	Not mentioned	Not mentioned
Fourth Industrial Revolution Response Plan	Not mentioned	Mentioned	Not mentioned	None
Digital Economy Plan	Not mentioned	Not mentioned	Mentioned	None
Government Body Focused on XR	None	None	Yes - National Center for Artificial Intelligence and Robotics (NCAIR)[85]	None

South Africa

| The South African government has taken a number of steps to harness the digital revolution for development. |

For instance, the South African government has prioritised narrowing the digital divide in the **National Development Plan** (NDP, 2030) with a specific focus on providing "ICT" support to players within the arts and culture sectors. This overarching long-term development plan also recognises the importance of building information technology infrastructure and the potential for the digital economy to unlock job creation while also increasing productivity and efficiency. The government also acknowledges that there is a huge digital skills gap in South Africa and commits to wider and deeper investment in education and skills training, with the aim of enabling high-value employment.

In April 2019, the South African government set up the **Presidential Commission on the Fourth Industrial Revolution** (4IR) with the aim of creating a unified blueprint on how South Africa plans to respond to 41R developments.

The commission was able to release a diagnostic report in October 2020, in which the following points and recommendations were highlighted:

1. The potential for industrial and household application of technologies that alter the physical and philosophical boundaries between the human and the non-human. Although AR/VR is not explicitly mentioned as one of these technologies, the report has a technological cluster named "physical world-oriented technologies" which includes artificial intelligence, robotics, advanced materials and 3D printing. **Simulation is highlighted as a key potential industrial application**; whereby real-time decision impact assessments can be made, and virtual networks can be created.

2. The importance of **building key technology infrastructure** building blocks such as National fibre infrastructure and connectivity; last-mile wireless infrastructure with a focus on 5G; transparent spectrum allocation rules and a clear and predictable policy framework to support mobile and broadband developments; and leveraging the Centre for High-Performance Computing[86] to ensure the provision of high-speed and high-bandwidth connectivity.

3. Creating **institutional and operational capacity** by enabling speed in enacting legislation that can foster value-adding technologies; restructuring institutions to eliminate the duplication of infrastructure and resources; and restructuring ICT governing bodies to better align with trends in technology.

4. **Intentional investment in human capital** with a focus on stackable competencies that are **micro-credentialled, industry-aligned** and allow people to enter and exit the educational system at multiple points as part of a lifelong learning process.

One of the key milestones that have been achieved since the release of the report has been the establishment of the Artificial Intelligence Institute.[87] This signals that there is an opportunity to create tangible steps towards the enablement of cutting-edge technology in South Africa, especially when there is a clear strategic agenda in place.

Kenya

| The Kenyan government has also clearly prioritised the digital economy having put in place a robust digital economy blueprint, masterplan and ICT policy framework. |

The **Kenyan Digital Economy Blueprint (2019)**[88] puts an emphasis on the expansion of digital infrastructure and the development of digital skills. Specifically, the government has committed to increasing the percentage of broadband and mobile network penetration (including 5G) and increasing the percentage of mobile and smart device penetration. Additionally, there is a clear focus on promoting digital skills training by incorporating digital skills content in the national curriculum and by launching digital literacy programmes.

The Kenyan government has also released a **Digital Masterplan 2022-2032**.[89] This document further emphasises the government's commitment to increasing national connectivity and bandwidth capacity. Some examples of specific projects that are related to these efforts include the construction of 100,000 km of national fibre optic connectivity network, the rehabilitation of 2500 km of damaged/old fibre network and the rolling out of the latest technology for mobile network infrastructure across the country.

The **Kenyan Digital Masterplan 2022-2032** identifies virtual reality as a key emerging technology along with 3D and 2D modelling, AI, Big Data and the Internet of Things. However, it's quite clear that there is a bit more emphasis on AI as there is a proposal to create a national AI masterplan, in order to adequately respond to the developments and opportunities that the technology presents. Additionally, the government **set up a blockchain and AI task force in 2018**.[90]

Although the Kenyan government seems to focus a lot more on AI as an emerging technology, there is still room to foster other emerging technologies through the **Kenya Innovation Agency (KENIA)** - which has been mandated to manage the national innovation system. The key strategic priorities for this agency include capacity development, information dissemination and awareness, commercialisation, shaping policies and legal frameworks, fostering partnerships and linkages as well as enabling funding.

Kenya also launched the **National ICT Policy in 2019** with the vision of being a competitive knowledge-based economy.

This policy framework has four key focus areas namely:

Mobile First

Creating access by focusing on mobile and wireless infrastructure.

Market

Increase the overall size of ICT contribution to the digital and traditional economy to 10% of GDP by 2030.

Skills & Innovation

Jump-starting a self-supporting ecosystem that will produce world-class research, technology products and industries.

Public Service Delivery

All arms of government to build, deploy, operate and manage locally built back-end and front-end systems to deliver all public services online.

Nigeria

| The Nigerian government has also prioritised the digital economy by releasing the National Digital Economy Policy and Strategy (NDEPS 2020-2030). |

Similar to Kenyan and South African digital policies, Nigeria has also prioritised digital literacy and skills, digital infrastructure, the fostering of emerging technologies and the effective regulation of the digital economy.

With digital literacy and skills, the focus is on embedding digital skills-building within the national curriculum and also through on-the-job training and incremental upskilling. The commitment to digital infrastructure involves deepening broadband penetration to 75% and deploying fibre optic cable under an open access model. Lastly, there is a focus on involving different stakeholders and regulatory bodies to co-author regulatory instruments.

| Notably, virtual and augmented reality has been mentioned as a key emerging technology, although there is no specific framework on how to foster the technology. |

There are already a number of existing regulatory instruments that govern the digital economy, which signals the Nigerian government is proactive in regulating technology across the country.

Some notable regulations include:

- Guidelines for Nigerian Content Development in Information and Communication Technology (ICT)
- Universal Access and Universal Service Regulations
- Framework and Guidelines for Information and Communication Technology (ICT)
- Framework and Guidelines for Public Internet Access (PIA) 2019
- Nigeria Data Protection Regulation 2019
- Consumer Code of Practice Regulations

In addition to the above, the Nigerian Parliament also recently passed the **Nigerian Start-up Bill 2022**,[91] which aims to foster the growth of the start-up economy in Nigeria. The Bill seeks to create a path that enables: capacity-building and training to start-ups, provides tax incentives to start-ups, investors, employees and start-up service providers as well as provides regulation support to the ecosystem.

Additionally, the Nigerian government has set up the N**ational Center for Artificial Intelligence and Robotics (NCAIR)**.[92] One of the key research and development focus areas for this emerging technology centre is extended reality (XR). NCAIR is a subsidiary of the **National Information Technology Development Agency (NITDA)**, which has been mandated to plan, research, develop, standardise, apply, coordinate, monitor, evaluate and regulate information technology practices, activities and systems in Nigeria. So far, NCAIR mainly facilitates excursions from schools, technical visits from organisations, research and capacity-building programmes which focus on knowledge-sharing and mentorship.

Although Nigeria doesn't provide specific guidelines and project milestones for enabling factors such as connectivity and digital skills training, the presence of NCAIR provides an avenue to specifically address any key issues or enabling factors that can help support the XR industry.

Côte d'Ivoire

| Overall, the Ivorian government recognises the potential for the country to be a digital hub for Francophone West Africa. Policymakers are however still in the early stages of enacting policies and frameworks that enable the digital economy. |

Unlike the other three countries covered in this report, Côte d'Ivoire has not formally or explicitly prioritised the digital economy as a key core pillar in their overarching development plans.

For instance, the latest National Development Plan (PND) 2021-2025 focuses on the six key pillars:[93]

1. The acceleration of the structural transformation of the economy through industrialisation and the development of clusters
2. The development of human capital and the promotion of employment
3. Private sector development and investment
4. Strengthening inclusion, national solidarity and social action
5. Balanced regional development, the preservation of the environment and the fight against global warming
6. The strengthening of governance, the modernisation of the State and cultural transformation

However, the **Ministry of Digital Economy, Telecommunications and Innovation launched the Startup4Gov initiative** which seeks to take an innovative approach to fostering collaboration between the actors of the innovation sector and the public administration. During the launch of this initiative, the Ministry also identified several young entrepreneurs as ambassadors of the initiative. In addition to this, the Ministry has started making efforts to engage stakeholders in order to forward the Start-up Bill, with the intention of improving the environment for Ivorian start-ups operating in the digital sector.[94]

Lastly, the Ivorian government doubled its commitment to protecting the local start-up ecosystem by introducing a **digital tax on foreign-supplied digital services**[95] in January 2022. There are however no specific policies recognising XR technology.

Appendix 2

List of Stakeholders & Organisations Scoped

Organisation	Country	Type of Stakeholder	Name of Stakeholder
AAG	Côte d'Ivoire	Researcher	Mohamed Diaby
Africa Comicade	Kenya	Builder, Enabler	Michael Oscar
Atlantica Ventures	Kenya, South Africa, Nigeria	Enabler, Decision Maker	Ik Kanu
CropLife International	Global, focus on India, Kenya	Builder, Enabler	Linda Froelich, Dana Farbo
Dream Zone	Côte d'Ivoire	Enabler	Bruno Thery
Electric South	South Africa	Builder	Ingrid Kopp
Euphoria Labs	Nigeria	Builder	Derrick Ikenga
Experis Immersive	Nigeria	Builder	Arome Ibrahim, Walid Kilzoni
Imisi3D	Nigeria	Builder	Judith Okonkwo
Leti Arts	Kenya, Ghana	Builder	Eyram Tawai
Megaheadz	Nigeria	Builder	Adesola Fakile

Meta-Versations	Kenya	Builder	Lynn Gitau
Power Builder	Côte d'Ivoire	Enabler	Mr. Douabou, Mr. Zocli
Research ICT Africa	South Africa	Researcher	Andrew Rens
Seamonster	South Africa	Builder, Enabler	Bella Rogerson
The Boiler Room	South Africa	Builder	Adi Stephan
Thrill Digital/Astra Metaverse	Nigeria	Builder	Delz Erinle
University of Johannesburg	South Africa	Researcher	Herman Pieter Myburgh
Virtual Human Computer Interaction Lab	Nigeria	Researcher	Eugene Ohu
Virtual is Real	Kenya	Builder	Matthew Munyao
WITS University - Fak'ugesi Festival	South Africa	Enabler	Tegan Bristow
XRGlobal	Global, focus on Kenya and Mozambique	Builder	Bryan White
SwiftXR	Nigeria	Builder	Hammed Arowosegbe, Isiaq Gbadamosi

List of Joint Solutions Workshop Participants

Organisation	Country	Type of Stakeholder	Name of Stakeholder
Imisi3D	Nigeria	Builder	Judith Okonkwo
Virtual is Real	Kenya	Builder	Matthew Munyao
The Boiler Room	South Africa	Builder	Mark Hocker
The Boiler Room	South Africa	Builder	Adi Stephan
Virtual Human Computer Interaction Lab	Nigeria	Enabler	Dr. Eugene Ohu
University of Johannesburg	South Africa	Enabler	Herman Pieter Myburgh
Council for Scientific and Industrial Research	South Africa	Enabler	Pieter Lange

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