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Enhancing the Digital Transformation of African Universities: Covid-19 as Accelerator

Paul Tiyambe Zeleza* & Paul Mzee Okanda**

Abstract

The COVID-19 pandemic has had negative effects on virtually every sector of the global economy and educational institutions have not been spared. This has inevitably led to the need for African think tanks to consider ways through which the continent's unprecedented youth bulge could be the cog around which growth and competitiveness of the African economy could be achieved. The first section introduces the paper and highlights how Higher Education Institutions (HEIs) have a key role to play towards ensuring the youth are adequately equipped with skills that are relevant to the twenty-first century's digital transformation. The second section discusses the theories behind the mega trends of the twenty-first century by international agencies, consultancy firms, governments, academics, and pundits while the third section examines the digitalization of HEIs and cites various publications on higher education and its evolution in the digital era. The fourth section builds on the authors' findings from previous sections to detail a twelve-point Digital Transformation Agenda for Africa. The fifth section highlights the technological infrastructure that is required to support Africa's Digital Transformation Agenda and twenty-first century research and innovation before the authors draw conclusions.

Résumé

La pandémie de COVID-19 a eu des effets négatifs sur pratiquement tous les secteurs de l'économie mondiale et les institutions éducatives n'ont pas été épargnées. Cela a inévitablement conduit à la nécessité pour les groupes de réflexion africains d'examiner les moyens par lesquels l'explosion démographique sans précédent de la jeunesse africaine pourrait être la roue

* Vice Chancellor, Professor of Humanities and Social Sciences, United States International University-Africa, Kenya. Email: pzeleza@gmail.com

** Director of ICT, United States International University-Africa, Kenya. Email: pokanda@usiu.ac.ke

d'engrenage qui entraînerait la réalisation de la croissance et de la compétitivité de l'économie africaine. La première partie est une présentation de l'étude dans laquelle nous soulignons le rôle majeur que les établissements d'enseignement supérieur (EES) doivent jouer pour permettre aux jeunes étudiants de disposer des compétences nécessaires à la transformation numérique du XXIe siècle. La deuxième partie aborde les théories qui sont à la base des mégatendances du XXIe siècle et qui sont avancées par les agences internationales, les cabinets de conseil, les gouvernements, les universitaires et les experts, tandis que la troisième partie se penche sur la numérisation des EES, en citant diverses publications sur l'enseignement supérieur et son évolution à l'ère numérique. La quatrième partie s'appuie sur les conclusions des auteurs des parties précédentes pour détailler un programme de transformation numérique en douze points pour l'Afrique. La cinquième partie met en évidence l'infrastructure technologique nécessaire pour soutenir le programme de transformation numérique de l'Afrique, ainsi que la recherche et l'innovation du XXIe siècle, avant que les auteurs ne tirent leurs conclusions.

Introduction

The Covid-19 pandemic has devastated global economies, healthcare systems, and institutions including universities. It has accelerated trends towards the digitalisation of economic and social life and the need for digital skills. This article focuses on how African higher education institutions can embrace these changes to survive and succeed in the emerging 'new normal'. The pandemic has exposed the huge developmental challenges that African universities face, while at the same time it has opened immense new opportunities for transformation. The continent is indeed at the proverbial crossroads in which the multiple demographic, economic, ecological, political, and social problems confronting it can be turned into possibilities if managed with strategic, systemic, and smart interventions, and the seriousness they deserve.

One of the continent's biggest assets is its rapid population growth. If properly harnessed, the youth bulge not only promises to become the continent's largest population ever, but also potentially its most educated and skilled. It is this population upon whose weighty shoulders the continent has placed a historic opportunity to overcome its half millennia of global marginality, underdevelopment, and dependency, and begin realising the long-deferred dreams of constructing integrated, inclusive, innovative democratic developmental states and societies. The ghastly alternative is a Malthusian nightmare of hundreds of millions of uneducated, unemployable, and ungovernable marauding masses of young people, a future of unimaginable dystopia.

Educational institutions including universities have a monumental responsibility to turn the youth explosion into a dividend rather than a disaster. This entails removing prevailing skills and jobs mismatches, upgrading the employability skills of the youth, and strengthening and reforming educational institutions to prepare them for the jobs of the twenty-first century, which increasingly require digitalised competencies. For this to happen, higher education institutions themselves must undergo and embrace digital transformation. Covid-19 suddenly shoved universities, which are renowned for their aversion to change and notoriously move at a snail's pace, into the future as they moved teaching and learning, administrative and support services, research activities, and even their beloved seminars, symposia, and conferences online.

In this article, we examine the digital transformation of higher education. First, it begins by placing the changes, challenges and opportunities facing contemporary Africa in the context of the mega trends of the twenty-first century in which the digitalisation of the economy, society, politics, work, education and even leisure and interpersonal relations increasingly looms large. Second, the article examines global developments in the digitalisation of higher education. Third, we present a twelve-point digital transformation agenda for African universities. Finally, the question of building Africa's technological capacities to ensure that the continent is a major technological player and not a pawn, a dynamic creator not just a passive consumer of technology, is broached and analysed. We believe that without it, the digital transformation of not only African universities but the continent's economies and societies will remain incomplete and keep them in perpetual underdevelopment.

Mega Trends of the Twenty-first Century

There is no shortage of diagnoses and prognoses of the trends and trajectories of the twenty-first century by international agencies, consultancy firms, governments, academics, and pundits. The projections and predictions of the future are as varied as their progenitors and prognosticators reflecting their divergent institutional, ideological, intellectual, and even individual investments and proclivities. At a more collective and policy level they find articulation in national, regional, and global visions. Examples include Kenya's Vision 2030, East Africa's Vision 2050, the African Union's Agenda 2063, and the United Nation's Sustainable Development Goals.

The futuristic soothsayers were particularly busy at the turn of the new century and millennium, but they are by no means gone. A recent compelling and controversial forecast of the unfolding century can be seen

in Yuval Noah Harari's book, *21 Lessons for the 21st Century*. He identifies five developments under which he outlines specific challenges. The first is what he calls 'The Technological Challenge' (under which he discusses disillusionment, work, liberty and equality); the second, 'The Political Challenge' (community, civilisation, nationalism, religion and immigration); the third, 'Despair and Hope' (terrorism, war, humility, God, secularism); the fourth, 'Truth' (ignorance, justice, post-truth, science fiction); and the fifth, 'Resilience' (education, meaning, meditation).

One of us (Zeleza) is writing a book, *The Long Transition to the 21st Century: A Global History of the Present*, which seeks to examine the major features of the contemporary world, how they came about, and their differentiated manifestations in different world regions. It is divided into five chapters. The first is titled, 'The Rise of the People' (on social movements and struggles for emancipation and empowerment); the second, 'The Emergence of Planetary Consciousness' (on the development of global consciousness fostered by the processes of globalisation and growth of environmental awareness); the third, 'The Digitalisation of Everything' (on transformations brought about by digital information and communications technologies on every aspect of social life); the fourth, 'The Restructuring of the Geopolitical Order' (on shifting global hegemonies, hierarchies and struggles); and the fifth, 'The Great Demographic Reshuffle' (on changing demographic regimes and migration processes and patterns).

In the context of this article, three of these phenomena are particularly pertinent. The first centres around the Fourth Industrial Revolution. The term often refers to the emergence of quantum computing, artificial intelligence, the Internet of Things, machine learning, data analytics, big data, robotics, biotechnology, nanotechnology, the convergence of the digital, biological, and physical domains of life, and the digitalisation of communication, connectivity, and surveillance. Africa participated in the three revolutions lately as a pawn rather than a player.

During the first industrial revolution of the mid-eighteenth century the continent paid a huge price through the Atlantic slave trade that laid the foundations of the industrial economies of EuroAmerica. Under the second industrial revolution of the late nineteenth century Africa was colonised. The third industrial revolution that emerged in the second half of the twentieth century coincided with the tightening clutches of neo-colonialism on Africa. If the continent continues to be a minor player, content to import technologies invented and controlled elsewhere, its long-term fate might not be confined to marginalisation and exploitation as with the other three revolutions but descend into irreversible global irrelevance.

The second major trend centres on hegemonic shifts in the world system. The global hegemony of the West that has survived over the last half millennium appears to be ending with the rise of Asia and other emerging economies of the global South. A harbinger of the hegemonic rivalries that are likely to dominate much of the twenty-first century is the trade war between a declining United States and a rising China. The consequences of previous hegemonic struggles for global power for Africa varied.

The imperial rivalries between Britain, the world's first industrial power, and industrialising Germany, in the late nineteenth and early twentieth centuries, culminated in the 'New Imperialism' that engendered both the colonisation of Asia and Africa and World War I. In contrast, the superpower rivalry between the former Soviet Union and the United States spawned the geopolitical spaces for Asian and African decolonisation. What will the current reconfiguration of global power bring for Africa? How can Africans ensure it creates opportunities for development?

Africa's prospects in the twenty-first century will be inextricably linked to the third major transformation, namely, profound changes in world demography. This is characterised by, on the one hand, an ageing population in the global North and China, thanks to its one-child policy imposed from 1979 to 2015, and on the other, population explosion in some regions of the global South, principally Africa. Currently, 60 per cent of the African population is below the age of twenty-five.

The continent is expected to have on current trends, 1.70 billion people in 2030 (20 per cent of the world's population), rising to 2.53 billion (26 per cent) in 2050, and 4.5 billion (40 per cent) in 2100. It is estimated that in 2100 Africa will have a large proportion of the world's labour force. Thus, educating and skilling Africa's youths is critical to the future of Africa itself and the rest of the world. Doing so will yield a historic demographic dividend, whereas failure will doom Africa's prospects for centuries to come.

Digitalisation of Higher Education

Higher education institutions have a fundamental role to play in enhancing the development and nurturing of demand-driven digital and technical skills because of their quadruple mission, namely, teaching and learning, research and scholarship, public service and engagement, and innovation and entrepreneurship. This mission is particularly pressing for African universities, the bulk of which were established after independence by the developmentalist state as locomotives to catapult the continent from the perils of colonial dependency and underdevelopment to the possibilities of sustainable development.

As with every other sector, higher education institutions are facing massive transformations that require continuous reform to make them better responsive to the unyielding and unpredictable demands of twenty-first century economies, societies, polities, and ecologies. The restructuring of universities is necessitated by pervasive and escalating digital disruptions, rising demands for public service and engagement, changes in the credentialing economy, and escalating imperatives for lifelong and life-wide learning. Given the changing nature and future of jobs, today's youth will not only have multiple jobs but several careers, some of which have not even been invented.

The outbreak of the Covid-19 pandemic exposed widespread differences and inequalities in terms of national capacities to manage the crisis and its costs. It forced higher education institutions around the world to embrace distance teaching and learning using online platforms as never before. They had to learn to do more with less as their financial resources became strained as never before and their faculty and students faced the stresses of massive readjustment. Many institutions rose to the occasion as they leveraged existing and acquired new digital technologies, while faculty and students adapted to the new normal.

The unprecedented crisis revealed differentiated institutional resources, access to information technology, and capabilities to transition to online teaching and learning. The pandemic also underscored challenges of access by faculty and students to digital technologies and broadband based on the social dynamics of class, location, gender, and age. It simultaneously exposed and eroded prevalent distrust and discomfort with online compared to face-to-face teaching and learning, and widespread concerns about the quality of online instruction by students, parents, and employers.

A few months before the world was engulfed by the Covid-19 pandemic, the International Association of Universities (IAU) published an important report, Higher Education in the Digital Era.[1] The report contained results of a global consultation encompassing 1039 public and private higher education institutions in 127 countries (29 per cent from Europe, 27 per cent from Asia and the Pacific, 21 per cent from Africa, 17 per cent from the Middle East, and 5 per cent from Latin America and the Caribbean). Globally, only 16 per cent of respondents found national regulatory policies supportive for higher education transformation in the digital era; 32 per cent were mostly supportive with some exceptions; 36 per cent were variably supportive and constraining; and 17 per cent mostly unsupportive. The responses from African institutions were 19, 26, 37 and 19 per cent respectively. Overall, Asia had the most positive assessment, and Europe the most negative.

The report also investigated the national financial framework for higher education. Only 7 per cent globally deemed the frameworks highly supportive; 26 per cent mostly supportive with some exceptions; 43 per cent variably supportive and constraining; and 24 per cent mostly unsupportive. Overall, Asia led with 43 per cent reporting highly and mostly supportive, followed by the Middle East at 40 per cent, Latin America and the Caribbean at 36 per cent, Africa at 30 per cent, and Europe at 27 per cent.

As for internet infrastructure, the variations favoured the more developed regions. The proportion of individuals out of 100 using the internet stood at 80.9 per cent in the developed countries, 45.3 per centin developing countries, and 19.5 per cent in less developed countries, with a world average of 51.2 per cent. Europe led with 79.6 per cent, followed by the Commonwealth of Independent States at 71.3 per cent, the Americas at 69.6 per cent, the Arab states at 54.7 per cent, and Africa was at the bottom with 24.4 per cent. The quality of internet infrastructure in Africa is exceptionally poor: only 7 per cent find it satisfactory, compared to 39 per cent in Europe; and 21 per cent in Africa find it not good, compared to 2 per cent in Europe.

There are also glaring inequalities in the spatial distribution of internet facilities. At a global level, 34 per cent reported that internet infrastructure was good in big cities, but poor in rural areas. The equivalent figures were 58 per cent for Latin America and the Caribbean, 47 per cent for Asia and the Pacific, 39 per cent for Africa, 26 per cent for the Middle East, and 17 per cent for Europe.

Clearly, enhancing the technological transformation of higher education depends on levels of national investments in Information and Communications (ICT) infrastructure. The global digital divide remains real and daunting. High inequalities in the spatial distribution of internet facilities deprives tens of millions of people around the world, especially in Africa, of access to information, knowledge, and networks. Equally critical are institutional investments in IT, and here too, Africa lags awfully behind. According to the IAU report, 39 per cent noted digital infrastructure was a significant obstacle at the institutional level compared to 7 per cent in Europe, representing the highest and lowest global levels respectively.

Higher education and research institutions tend to use national research education networks (NRENs) as an alternative to commercial Internet Service Providers. On the issue of national support for National Research Education Networks (NRENs), Africa is also at the bottom with 67 per cent of respondents noting the level of support was very or somewhat high compared to the world average of 71 per cent, and 74 per cent for Asia

and the Pacific, 73 per cent for the Middle East, 72 per cent for Europe, and 50 per cent for Latin America and the Caribbean. Africa led in the use of NRENs by higher education institutions at 70 per cent compared to a world average of 62 per cent, the same as Asia and the Pacific, with 68 per cent for Latin America and the Caribbean, 64 per cent for the Middle East, and 56 per cent for Europe.

Institutional commitment to digital transformation is obviously critical to making the necessary investments in IT infrastructures. The IAU report shows generally high levels of commitment from institutional leaders. Africa led with 77 per cent claiming strong leadership support, compared to 74 per cent for the Middle East, 73 per cent for Asia and the Pacific, 70 per cent for Europe, and 61 per cent for Latin America and the Caribbean. At a global level, advocacy for digital transformation was bottom-up (56 per cent) rather than top-down (41 per cent). For Africa it was 34 and 63 per cent respectively. Top-down strategies were most pronounced in Europe (49 per cent) and Latin America and the Caribbean (49 per cent), while the Middle East led with bottom-up approaches (70 per cent).

Approaches to digital transformation varied. Only 18 per cent of respondents globally, 18 per cent in Africa, 14 per cent each in Europe and Latin America and the Caribbean, 21 per cent in Asia and the Pacific, and 33 per cent in the Middle East, expected to continue doing the same things in their teaching and governance with technology. A larger proportion, 43 per cent at the global level, expected to do things differently with technology; for Africa the proportion was 16 per cent, Latin America and Caribbean led with 63 per cent, followed by Europe at 53 per cent, Asia and the Pacific at 45 per cent, and the Middle East at 26 per cent. In Africa, 63 per cent were planning to do things differently but were limited by funds, while globally the figure was 38 per cent, for the Middle East 41 per cent, Europe 33 per cent, Asia and the Pacific 32 per cent, and Latin America and the Caribbean 23 per cent.

Digital transformation was integrated in institutional strategic plans in all the regions. According to the respondents, globally it was 75 per cent, ranging from 77 per cent for Africa, Asia and the Pacific, to 76 per cent for Latin America and the Caribbean, 74 per cent for Europe and 73 per cent for the Middle East. Budget allocation for digital transformation was 55 per cent, from a high of 60 per cent in Africa to a low of 50 per cent in Latin America and the Caribbean, with the Middle East (56 per cent), Asia and the Pacific (55 per cent), and Europe (51 per cent) in between. Overall, the bulk of the institutional budget allocated was mostly between 0–9 per cent (35 per cent) and 10–19 per cent (29 per cent). In most cases, 73 per cent of institutions reported having a senior person in charge of digital

transformation. Training opportunities for faculty and staff were generally in the same range.

The survey further revealed regional divergences in online governance of student data and learning processes. Globally, 63 per cent of institutions reported managing enrolment and student data fully online, with a high of 72 per cent in Europe and a low of 55 per cent in Africa, 70 per cent for the Middle East, 60 per cent for Asia and the Pacific, and 58 per cent for Latin America and the Caribbean. But the use of learning management systems was lower. The range, as reported by institutional leaders, was from 47 per cent in Latin America and the Caribbean to 24 per cent in Africa, while it was 40 per cent in Asia and the Pacific, 34 per cent in Europe, and 33 per cent in the Middle East. Online data management creates both new possibilities and perils in tracking and managing student enrolments, learning and outcomes. This raises the issue of data privacy and protection. Globally, 55 per cent of institutions reported having full ethical guidelines or data privacy policies. Africa ranked lowest at 43 per cent, compared to 65 per cent in Latin America and the Caribbean, 64 per cent in Europe, 49 per cent in Asia and the Pacific, and 41 per cent in the Middle East.

Similarly varied was the use of technology and new modalities in teaching and learning. The global average for full integration of technology in teaching was 31 per cent. Africa ranked second to the Middle East at 38 per cent and 40 per cent respectively. The lowest was Latin America and the Caribbean at 11 per cent, followed by Asia and the Pacific at 33 per cent, and Europe at 23 per cent. When it comes to the full use of the new teaching modalities of flipped classrooms, blended and online learning Africa ranked last at 14 per cent, and Latin America and Caribbean on top at 49 per cent, while Asia and the Pacific scored 32 per cent, Europe 24 per cent, and the Middle East 22 per cent. The global average was 27 per cent. Very few of the responding institutions provided fully online courses: 32 per cent had none, in 14 per cent of institutions they comprised 1–4 per cent of all courses, and in 13 per cent between 5–9 per cent.

In much of the world most undergraduate courses were largely delivered by lectures. Africa led in the category 'mostly lecture based learning but combined with problem-based learning' scoring 56 per cent against a world average of 49 per cent and ranked lowest under 'mostly problem based learning but combined with lectures' at 11 per cent compared to a world average of 19 per cent. Only 35 per cent of institutions globally reported having fully reconsidered skills and competencies required of students in the past three years. The regional rankings were Latin America and the Caribbean (56 per cent), Asia and the Pacific (36 per cent), Europe (35 per cent), Africa (31 per

cent), and the Middle East (22 per cent). As for reviews of learning outcome assessments, the global average was 42 per cent, and was lowest in Africa at 33 per cent and highest in Latin America and the Caribbean at 49 per cent.

Digital literacy is increasingly becoming a critical skill. However, the survey revealed relatively low levels of national support for digital literacy and computational thinking. The global average reporting 'Yes, very much' was 19 per cent; Africa registered at the bottom with 12 per cent, while Asia, the Pacific and the Middle East were on top with 19 per cent each. At the institutional level, digital literacy was viewed as a transversal learning outcome in 22 per cent of the responding institutions globally, the same figure as for Africa.

Equally low were levels of national support for open educational resources (OER). In terms of national initiatives in favour of OER, the global average for 'Yes, very much' was 16 per cent, like Africa's; while in terms of support for online bibliographies or libraries for online content the global average was 23 per cent and for Africa 16 per cent compared to a high of 32 per cent each for Europe, Latin America and the Caribbean. At the institutional level only 19 per cent reported fully creating and using OER at the global level, while in Africa 9 per cent did so, which was below other regions. Commitment to open science was much lower at the national level (17 per cent) compared to the institutional level (56 per cent).

The impact of digital transformations on the nature of jobs and the future of work is increasingly appreciated. As a result, continuous reskilling and upskilling through lifelong learning is becoming more and more imperative. Only 18 per cent of respondents globally agreed 'Yes, very much' that there were national initiatives in support of lifelong learning; for Africa it was 16 per cent, Europe 24 per cent, Asia and the Pacific 18 per cent, the Middle East 14 per cent, and Latin America and the Caribbean 8 per cent. At the institutional level, 84 per cent reported having adult learners, globally led by Europe with 90 per cent, then Africa at 88 per cent, Latin America and the Caribbean at 87 per cent, and Asia, the Pacific and the Middle East with 77 per cent each. African institutions reported a 65 per cent increase in adult learners over the past three years, compared to an average of 55 per cent globally. African institutions also had higher expectations (68 per cent) that adult learners would increase than other regions (the global average was 61 per cent).

Overall, it is evident from the survey that digital transformation was being pushed by the leadership, followed by faculty, staff, students, governing board, and national authorities. The respondents identified the key achievements using new technologies as, in descending order, improved governance of information, new learning pedagogies to enhance the

student experience, improved research, and improved accessibility to higher education. As for challenges, they selected financial costs, the university culture's slowness to adapt to change, lack of interest of faculty and staff to change, lack of capacity building, unreliable internet, and national policies, in that order. For Africa the order of challenges was listed as financial costs, unreliable internet, lack of capacity building, university culture, lack of faculty and staff interest, and national policies.

The report concluded by examining perceptions of current transformations. On institutional readiness towards change, the majority, 53 per cent, indicated they were 'very ready'. Respondents from Africa were in the lead at 46 per cent, followed by Latin America and the Caribbean at 35 per cent, Asia and the Pacific at 33 per cent, the Middle East at 30 per cent, and Europe at 21 per cent. African respondents (77 per cent) believed more strongly than others (the global average was 61 per cent) that digital transformation is necessary and inevitable in preparing students to actively participate in society. They also more strongly agreed that digital transformation exacerbates socio-economic divides within and between countries by 35 per cent to 27 per cent.

Further, 89 per cent of African respondents strongly agreed, compared to 75 per cent globally, that digital transformation and new technologies represent an opportunity to expand access to higher education. By a margin of 58 to 39 per cent they strongly believe these technologies will lower the costs of higher education; 97 to 79 per cent strongly believe they are essential to improving higher education; 90 to 77 per cent that they can enhance the quality of higher education; and 78 to 58 per cent that higher education plays an important role in shaping digital transformation. Yet only 27 per cent compared to 33 per cent globally believe that their institutions were equipped for the future in terms of the emerging technologies and opportunities, compared to 40 per cent in Asia and the Pacific, 35 per cent in Europe, 33 per cent in Latin America and the Caribbean, and 30 per cent in the Middle East.

Clearly, even before the outbreak of the Covid-19 pandemic higher education institutions around the world including in Africa were increasingly aware and committed to the challenges and opportunities of emerging technologies. They understood the need to undertake transformations at national and institutional levels in terms of creating enabling policies, making the necessary financial investments in technological infrastructures and capacities, promoting institutional leadership, culture, and commitment to change, and providing opportunities for faculty and staff training and development. Further, it was appreciated that critical attention needed

to be paid to the inequalities of access and the ethical dimensions of data protection and privacy in institutional data management.

Covid-19 has acted as an accelerator in the digitalisation of higher education. It is evident from numerous reports in the higher education and popular media that following closures of campuses as part of the containment measures imposed by governments against the pandemic, universities scrambled to transition to remote or distance teaching and learning using digital technologies. An informative comparative snapshot of how universities managed and continue to manage the massive disruptions engendered by Covid-19 is provided by the Association of Commonwealth Universities (ACU) that conducted a survey in May 2020 of its 500 member universities across fifty countries around the world.[2]

The transition to online education, research and administration revealed glaring digital divides among and within countries, as well as among and within universities in terms of digital capacities and access to data, devices and broadband. More positively, it helped change perceptions about the quality of online teaching and learning. By the beginning of April 2020, higher education institutions had closed in 175 countries affecting over 220 million students. The survey showed that 80 per cent of respondents reported teaching had moved online, while 78 per cent agreed it had affected their ability to conduct research, while 69 per cent reported they had been able to take research activities online.

The digital divide among countries was evident in the fact that 83 per cent of respondents in the high-income countries had access to broadband, compared to 63 per cent for upper-middle income countries, 38 per cent in lower middle-income countries, and 19 per cent from low-income countries. Institutions that were unable to move online were confined to the lower middle-income countries (19 per cent) and low-income countries (24 per cent). Only 33 per cent with broadband access strongly agreed that the pandemic had affected their ability to conduct research, compared to 43 per cent of respondents without broadband access.

Within institutions, the distribution of access to broadband ranged from 74 per cent for senior leaders to 52 per cent of those in professional services, to 38 per cent for academics, and 30 per cent for students. Institutional support for remote working in terms of devices or data was also skewed in favour of senior leaders and professional services staff (both 82 per cent), compared to students (45 per cent) and academics (40 per cent). Prior to the pandemic students were less likely than other groups to report always having worked online, while after the pandemic senior leaders were more likely than their counterparts to say they would work online frequently.

Perceptions of the quality of online teaching and learning showed marked improvement. Most respondents, 81 per cent, agreed that quality had improved since the pandemic; 90 per cent agreed that a blended degree, combining online and face-to-face learning, was equivalent to a degree earned only through face-to-face learning, while 53 per cent felt a degree earned solely through online learning was equivalent to one earned through face-to-face learning. As for online working, 65 per cent foresaw working online frequently after the pandemic, while 19 per cent foresaw doing so 'all of the time', and only 16 per cent said rarely, while 1 per cent said never.

Fifty-three per cent of respondents envisaged all (26 per cent) or most (28 per cent) departments would continue to use online teaching and learning, and only 4 per cent said that no departments would do so.

In terms of institutional commitments and capacity, 89 per cent agreed that their institution had the will to develop high-quality online teaching and learning, while 82 per cent of respondents agreed that their institution has the capacity to do so.

It was reported that universities were providing support for remote working, but with variations between countries and professional roles. Thirty-seven per cent noted their university contributed towards data costs, 31 per cent that they were provided with device(s), and 7 per cent that their institutions contributed towards device costs. The levels of support ranged from 87 per cent in high income countries, to 70 per cent in upper middle-income countries, 51 per cent in lower middle-income countries, and 52 per cent in low-income countries. Support was also provided in the form of faculty and staff training and development.

The most pressing challenges identified by respondents for remote working were internet speed (69 per cent), data costs (61 per cent), internet reliability (56 per cent), and time zones (38 per cent). Data costs were most pressing for those from low and lower middle-income countries, while those from high income countries cited time zones. As for online teaching and learning, the leading challenges were accessibility for students (81 per cent), staff training and confidence (79 per cent), connectivity costs (76 per cent), and student engagement (71 per cent). Respondents from low and lower middle-income countries emphasised connectivity costs, while those from high income countries stressed challenges relating to student perceptions of quality. In terms of impact on research, there were some disciplinary variations: in the natural, environmental and earth sciences 92 per cent of academics reported being affected, while in the arts, social sciences and humanities 61 per cent did so.

Twelve-point Digital Transformation Agenda for Africa

Based on data collected from Africa, the ACU noted that African universities faced challenges in managing Covid-19.[3] Many suffered from limited digital infrastructure, capacity and connectivity which made it difficult for them to transition online for education, research, and administration. These challenges were compounded by enduring financial strains worsened by severe budget cuts as student enrolments dropped and government funding declined. Fundraising has largely been negligible in most African universities.

Also evident was the digital divide across and within African countries. Across the continent respondents identified many challenges including accessibility of students (83 per cent), staff training and confidence (82 per cent), and connectivity costs (89 per cent). In terms of devices and connectivity, respondents indicated that 58 per cent had access to two devices, 82 per cent had access to mobile data and 35 per cent to broadband. In Kenya, 25 per cent of respondents reported having access to a desktop, while in Nigeria 15 per cent and in South Africa 13 per cent did. Regarding to broadband, 63 per cent of South African respondents had access compared to 54 per cent for Kenya, and 27 per cent for Nigeria.

Among the leading challenges for remote working respondents across the continent identified were data costs (77 per cent), internet speed (71 per cent) and internet reliability (65 per cent). An encouraging development was the growing provision of institutional support. Forty per cent of respondents received contributions toward data costs from their university, 22 per cent were provided with a device, and 8 per cent received a contribution toward device costs. Some institutions adopted innovative ameliorative measures, ranging from negotiating with technology companies zero-rated access or reduced subscription prices to educational content, to providing free dongles to students without remote connections.

There were of course national and intra-institutional variations. More likely to receive support were senior leaders and professional services than faculty and students. In terms of contributions to data costs 62 per cent of senior leaders received support as did 64 per cent of professional services. In the provision of devices 54 per cent of the former and 38 per cent of the latter received support.

As far as online teaching and learning are concerned, there was a marked shift. Prior to the pandemic only 16 per cent of respondents indicated online teaching had occurred in all or most departments; 74 per cent said that all or most teaching and learning were now online. Forty-seven per

cent expected that all or most departments would continue to use online teaching and learning. Again, there were national divergences. In Nigeria 44 per cent of respondents reported no teaching and learning had moved online, unlike South Africa and Kenya where no respondents said this to be the case. In South Africa 94 per cent of respondents stated all or most teaching was now online, compared to 62 per cent for Kenya and 22 per cent for Nigeria. Attitudes on the quality of online teaching and learning witnessed a marked shift as 80 per cent of respondents believed quality had improved; 49 per cent said they thought a degree earned exclusively online was equivalent, while 91 per cent agreed a blended degree is equivalent to a degree earned face-to-face.

African educators and policymakers now widely accept that the digital transformation of higher education is here to stay. They also appreciate more keenly the need to make significant investments and interventions in technology-based platforms for the higher education enterprise. In the context of the new realities and pressures, it is increasingly evident that the traditional instructional methods, modes of knowledge production and consumption, and institutional conceits of exclusivity are no longer tenable if higher education institutions are to remain relevant for Africa's regeneration.

A report on digital transformation for British universities recommends ten useful guiding principles that promote digital fluency among faculty and students; institutional digital innovation and progress; integrated working by creating inclusive and collaborative working environments; engaged learning by rethinking interactivity across physical and virtual spaces; personalised learning that motivates and facilitates individual student success; transformed learning spaces that are connected, coherent and compelling; inclusivity in design to accommodate diverse students and learning styles; building of learning communities for students that are safe, secure and empowering; learning infrastructure in a propitious technology environment that allows for continuous upgrading; and innovative learning based on continuous experimentation, learning and investment.[4]

Higher education will emerge from the Covid-19 pandemic profoundly changed from the most catastrophic crisis it has ever faced and for which it was not prepared. The EDUCAUSE 2021 'Top IT issues' foresees the emergence of what it calls alternative and overlapping futures involving three scenarios: Restore, Evolve and Transform.[5] The Restore scenario is a story of institutional survival focused on reclaiming the institution's pre-pandemic financial health, while the Evolve scenario applies to 'institutions that will choose to incorporate the impact and lessons of the pandemic into their culture

and vision.' Institutions embracing the Transform scenario 'plan to use the pandemic to launch or accelerate an institutional transformation agenda.'

For example, on the issue of financial health, the Restore scenario focuses on cutting costs, while the Evolve scenario focuses on 'increasing revenues and funding sources and on evolving the institution's business model.' On online learning, the 'Restore version takes a structural approach to online learning – emphasizing supports, processes, and policies – whereas the Evolve version focuses on advancing the quality of online learning.' On information security the 'Restore version is a tactical one that covers returning to campus as well as cost-effectiveness and recovery. The Evolve version takes a strategic approach and expands the scope of cybersecurity efforts to include off-campus locations, in recognition of the need to adapt to constituents whose technology environments will never fully return to campus.'

For its part, the 'Transform version expands the role of technology (digital transformation) to not only reduce costs but also maximize value.' Transform institutions seek to prioritise changing institutional culture and promoting technology alignment. They also seek to develop 'an enterprise architecture to enable business outcomes, manage data to enable decision-making and future opportunities, streamline business processes, and enable digital resources to keep pace with strategic change.' For enrolment and recruitment, they endeavour to explore and implement 'creative holistic solutions for recruitment, including analytics-based marketing around student career outcomes, technology-enabled transfer agreements and partnerships, and use of social media to build student communities.'

Each African university must ask itself the question: what kind of institution does it wish to become in the post-Covid-19 era? Many of course will combine elements of all three – restoration, evolution, and transformation. Some may not survive, while others will thrive. Those that endure and excel will need to adopt the twelve-point agenda outlined below.

First, Covid-19 induced transition to remote delivery of education must turn to the development of a long-term digital strategic framework that ensures resilience, flexibility, experimentation, and continuous improvement. Digital transformation must be embedded in institutional culture from strategic planning processes and organisational structures to administrative practices and daily operations, while avoiding exacerbating existing inter- and intra-institutional inequalities for historically, socially and spatially disadvantaged communities. Universities must integrate digitalisation into their four core missions: teaching and learning, research and scholarship, public service and engagement, and innovation and entrepreneurship.

Second, universities have no choice but to make strategic and sustainable investments in digital infrastructures and platforms by rethinking capital expenditures that historically favoured physical plants and increase spending on technological and digital infrastructure. Their budgets must not only support a more robust online learning ecosystem, but also build in flexibilities to reallocate resources in the face of unexpected crises. Critical in this regard is building resilient and secure digital business continuity plans, strategies, and capabilities.

Third, African universities must develop online design competencies, both individually and through consortia with each other and overseas institutions, that are committed to mutually beneficial partnerships in promoting e-learning. Such consortial arrangements should encompass sharing technical expertise for online instructional design, pedagogy and curation, content development, and training of faculty and university leaders. Inter-institutional collaboration is more imperative than ever following the global transition to online teaching and learning spawned by Covid-19 because competition for students between universities in the global North and the global South is likely to intensify. Africa already loses many of its richest and brightest students to universities in the global North and increasingly the major emerging economies of Asia. Now, they stand to lose some middle-class students who can afford to enrol in online programmes by foreign universities that enjoy better brands than local universities.

Fourth, universities need to entrench technology-mediated modalities of teaching and learning. Higher education must embrace face-to-face, blended, and online teaching and learning, and raise the digital skills of faculty and students accordingly. Digital transformation promises to diversify students beyond the 18–24 age cohort, maximise learning opportunities for students, open new markets, and increase tuition revenues for universities. Blended and online teaching and learning offer much needed flexibility for students, who increasingly find it appealing and convenient for its space and time shifting possibilities. It also offers faculty 'opportunities to improve educational outcomes by adopting a wider range of learning activities, allowing greater flexibility of study times, space for reflection and a move to different forms of assessment.'[6]

Fifth, digitalisation provides opportunities for beneficial pedagogical changes in terms of curricula design and delivery that involves students and incorporates how they learn. It helps faculty to rethink learning and teaching practices, to see themselves less as imperious sages on the stage and more as facilitating coaches. In this transformed pedagogical terrain and relationship, universities ought to 'ensure their professional development strategies and plans include digital training, peer support mechanisms, and

reward and recognition incentives to encourage upskilling'.[7] An important part of this agenda is for universities to promote research that enables them to stay current with the changing digital preferences, expectations, and capabilities of students, faculty, and professional staff.

Sixth, universities should develop curricula that impart skills for the jobs of the twenty-first century. Such curricula must be holistic and integrate the classroom, campus and community as learning spaces; promote inclusive, innovative, intersectional and interdisciplinary teaching and learning; embed experiential, active, work-based, personalised and competence based learning; instil among the GenZ youth the mindsets of creativity, enterprise, innovation, problem-solving, resilience and patience rather than mindsets of passive learners and knowledge consumers who regurgitate information to pass exams. The extensive changes taking place require continuous reskilling, upskilling and lifelong learning. The growing importance of careers in science, technology, engineering, healthcare, and the creative arts, all within an increasingly technologically driven environment, necessitates the development of hybrid hard and soft skills.

Seventh, universities have a responsibility to embrace and use educational technologies that support the whole student for student success. According to the EDUCAUSE 2020 Student Technology Report[8] student success goes beyond degree completion. Holistic support encompasses 'access to advisors and to helpful advising technologies', raising students' awareness about 'the tools available to students, where to find those tools, how to use them, and how they can help advance educational and career goals.' Surveys show students also appreciate course-related alerts, nudges and kudos that are positive and offered early. Regular, constructive, targeted and personalised feedback makes a big difference; so does 'embedding a human assistant in the online virtual lectures and office hours [who] … through modeling, or observational learning, may persuade students to imitate the assistant .... The assistant could be a graduate teaching assistant, an undergraduate student, or a peer leader.'[9]

On technology use and preferences, it is important for universities to 'establish research-based instructional practices in all teaching modalities' and develop 'an acceptable use policy (AUP) for classroom uses of student devices that is informed by evidence-based practice and students' preferences for device use. Allow students to participate in the design of the AUP to create a digital learning environment in which they feel empowered to use their devices and to regulate their own behavior.' Also important is assessing 'student access to Wi-Fi and digital devices and work to ensure that every student has access to these critical technologies.'

Eighth, universities need to develop effective policies and interventions to address the digital divide and issues of mental health disorders and learning disabilities. Resources and new investments are required to provide opportunities to those trapped by digital poverty. An inclusive agenda for digital transformation must also include using the universal design for learning framework (UDL) 'when designing learning experiences and services to optimize learning for all people …. If technology and IT policies are thoughtfully and inclusively incorporated into a course guided by UDL, then ideally learner variability, choice, and agency increase, while the need for individual accommodations is greatly reduced.'[10]

Creating inclusive learning environments also entails investing in professional development for faculty to better prepare them to provide accessible instruction. Moreover, as universities seek to expand access to mental health services, they need to leverage technology-based interventions that do not just introduce new ways of offering services but also enable scaling of those services to multiple students online.

Ninth, as learning and student life move seamlessly across digital, physical, and social experiences, issues of data protection and privacy become more pressing than ever. Protecting personal data, especially relating to students, must be a priority through the provision of safe storage options and the development of policies and practices that are transparent and ethical. Students are generally comfortable with the institutional use of their personal data if it helps them achieve their own academic goals, but not for other gratuitous purposes. Thus, they need to know and have confidence in how the institution collects, stores, protects, and uses their personal data, and be able to view and update it, and opt out.

The proliferation of online harassment, especially against women and people from marginalised groups, requires institutional protections including creating codes of conduct against clearly defined online harassment, fostering an anti-harassment culture, and developing a centralised system of reporting and tracking. Growing dependence on digital technologies increases cyber security risks that require robust mitigation capabilities including conducting information security awareness campaigns.

Tenth, in so far as the market for online programmes is transnational, it is essential for universities to pay special attention to international students who face unique barriers in an online learning environment that require special redress. Generally, African universities are not serious players in the international education market. Online education opens new opportunities. The key barriers international students face in the virtual classroom include time differences, hard deadlines, limited connectivity and access, lack of

learning space, lack of scheduled support, lack of language support for non-native or secondary speakers of the language of instruction, remote class culture, invisible support, social isolation, and racial discrimination.[11]

The solutions include adopting asynchronous learning, allowing flexible timelines, providing connectivity support, offering safe learning spaces, replicating the class structure, providing language support, setting digital expectations early, building cultural bridges, providing remote support services, and practising micro-inclusions by encouraging 'teachers, staff and students to use subtle, inclusive ways to show international students they are welcome and valued'[12] and establishing safe 'virtual' spaces for international and marginalised students and faculty to talk openly.

Eleventh, higher education institutions must develop meaningful partnerships with external constituencies and stakeholders including digital technology and telecommunication companies. As the demands for return- on-investment increase from students and their families, as well as the state and society, pressures are growing on universities to demonstrate their value proposition and social impact. This translates into the question of graduate employability, closing the much-bemoaned mismatches between educational qualifications and the economy. This entails strengthening experiential learning and work-based learning, which requires strengthening connections with employers. Virtual learning not only necessitates and opens new ways of engaging industry, the economy and society, it also creates huge demands for digital skills for the emerging jobs of the twenty-first century.

Twelfth, the stakes for research have been raised for African higher education institutions. All along they have been expected to actively produce both basic and applied research and generate innovations that address the pressing problems of African communities, countries, the continent, and Africa's place in the world. However, levels of research productivity have remained generally low. Universities also have a responsibility to promote research and data-driven policy and decision-making. Following the disruptions and digital opportunities engendered by Covid-19, universities will increasingly be expected to anchor their research and innovation in the technological infrastructure that supports and enhances the opportunities of the Fourth Industrial Revolution for Africa.

Research, Innovation and Technological Infrastructure

As noted earlier, the Fourth Industrial Revolution is disrupting and transforming every sector. A critical facet of the technological revolution is advancing research and turning hindsight into insight to make our world

a better place, whether it's gene sequencing, predictive medicine, climate research, economic modelling, manufacturing with computer aided design or financial services trading and risk management.

The World Economic Forum (WEF) has produced numerous reports showing how the data-driven technologies of the Fourth Industrial Revolution are shaping the future of advanced manufacturing and production; consumer industries; energy, materials, and infrastructure; financial and monetary systems; health and healthcare; investing; media, entertainment, and sport; mobility through the creation of autonomous vehicles; and trade and global economic interdependence.[13]

In The Future Jobs Report 2020, the WEF forecasts massive changes in the jobs landscape by as soon as 2025. The report contends, 'we estimate that by 2025, 85 million jobs may be displaced by a shift in the division of labour between humans and machines, while 97 million new roles may emerge that are more adapted to the new division of labour between humans, machines and algorithms, across the 15 industries and 26 economies covered by the report.'[14] It identifies the top ten emerging jobs as: data analysts and scientists, artificial intelligence and machine learning specialists, big data specialists, digital marketing and strategy specialists, process automation specialists, business development professionals, digital transformation specialists, information security analysts, software and applications developers, and Internet of Things specialists, in that order.

Conversely, the top ten declining jobs mentioned are: data entry clerks, administrative and executive secretaries, accounting, bookkeeping and payroll clerks, accountants and auditors, assembly and factory workers, business services and administration managers, client information and customer service workers, general and operations managers, mechanics and machinery repairers, material-recording, and stock-keeping clerks.

'Data is the new oil' headlines abound and countries that can harness this data to extract value will have a significant competitive advantage. Data is even more valuable than oil, whose reserves on the planet are fixed. As Adam Schlosser notes, 'Unlike oil, increasing amounts of data are being generated at a pace that's hard to fathom: in the next two years, 40 zettabytes of data will be created – an amount so large that there is no useful framing exercise to demonstrate its size and scope. It's roughly equivalent to 4 million years of HD video or five billion Libraries of Congress …. Unlike oil, the value of data doesn't grow by merely accumulating more. It is the insights generated through analytics and combinations of different data sets that generate the real value.'[15]

Thus, harnessing data, advancing research, and drawing insights requires advances in computing and specifically High-Performance Computing (HPC). There is an intersection between technologies that are driven by the pertinent needs of twenty-first century workplaces such as machine learning, artificial intelligence, big data etc. and HPC. Huge technological strides in the development of hardware technology and computing architectures have played a big role towards making it possible for complex machine learning algorithms to be used to resolve real world problems and challenges from climate change to disease pandemics.

It is noteworthy that the future jobs mentioned above in areas such as data analytics, big data, artificial intelligence, and robotics will require advanced computing technologies and performance in order to support the operational roles that employees will play in organisations. Notwithstanding the financial pressures that the Covid-19 pandemic has visited on Africa, the continent must make strategic and smart investments in the digitalisation of its economies, societies, and educational institutions. At most it has a decade to do so if it is not to be permanently left behind by the rest of the world.

During the first industrial revolution of the late eighteenth century Africa was reduced to providing labour for the Atlantic slave trade that developed EuroAmerica and underdeveloped the continent. Under the second industrial revolution of the late nineteenth century, colonised Africa supplied raw materials that deepened its dependency. Africa participated in the third industrial revolution of the late-twentieth century as a collection of neo-colonial peripheries. In exchange for its labour Africa received trinkets, its raw materials fetched a pittance on world markets, and later the backward postcolonies were sold 'appropriate technologies'. Now, the continent is even paying dearly for the privilege of exporting its data!

The danger for Africa of remaining peripheral to the Fourth Industrial Revolution is not exploitation and marginalisation, but historical irrelevance, as noted earlier, becoming a landmass of disposable people. Critics caution that Africa should not embrace the Fourth Industrial Revolution at the risk of 'premature de-industrialisation'.[16] Others warn of the dangers of data manipulation and cyber-attacks and that the continent is not ready, an argument that condemns Africa to eternal technological underdevelopment.[17] On the contrary, as Ndung'u and Signé argue, the transformative potential of the Fourth Industrial Revolution for Africa is substantial. It promises to promote economic growth and structural transformation; fight poverty and inequality; reinvent labour skills and production; increase financial services and investment; modernise agriculture and agro-industries; and improve healthcare and human capital.[18]

To play a pivotal role in the Fourth Industrial Revolution, African higher education institutions need a change of mindset and to recognise their role as centres for teaching and learning, research, knowledge, and technology transfer to current and future generations. They need to collaborate among themselves and with industry, government, and other key players to undertake research and innovation, and to develop digital technologies that address the continent's most enduring and difficult needs and opportunities, not simply consume technologies produced by others.

Africa's leading research universities need to reinvent themselves by using advanced technologies such as HPC that support supply of human resources for future jobs, as well as training faculty that have the requisite skills and competency to equip students with the skills required to take up future jobs. The digital transformation agenda has huge implications for universities' institutional capacities, financial resources, human capital in relation to development and delivery of curricula and technological infrastructures. Currently, the continent's HPC capacity is abysmally low as shown below.

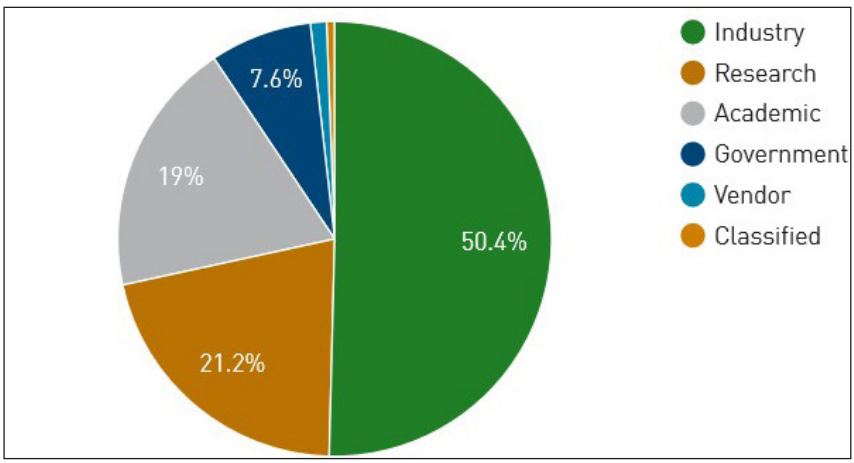

Figure 1: World segments of HPC systems share
Source: Top500.org, 2017

Data presented at the HPC conference held at USIU-Africa and the United Nations Environment Assembly (UNEA) in December 2017 underscored Africa's insignificant capability for the HPC that is essential for the digital revolution, as evident in Figure 2.

Figure 3 gives a further breakdown of HPC distribution by country. The findings show that after US and China, Germany claims the most HPC systems followed by Japan, France and the UK.

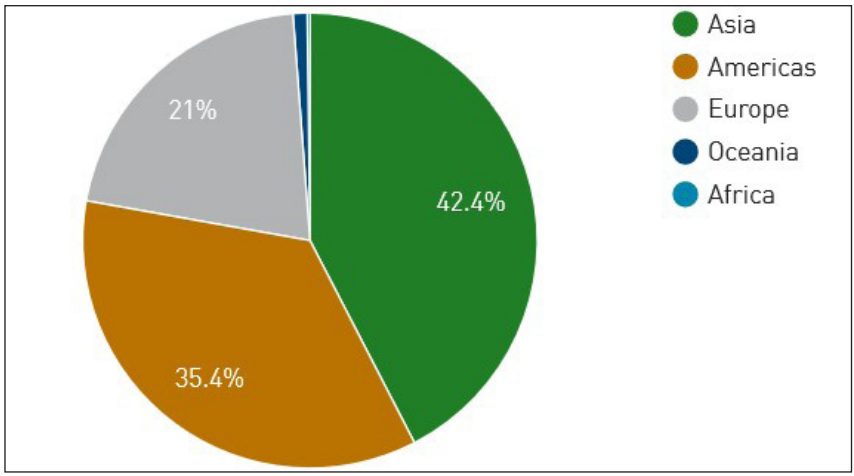

Figure 2: Continents' HPC systems share
Source: Top500.org, 2017

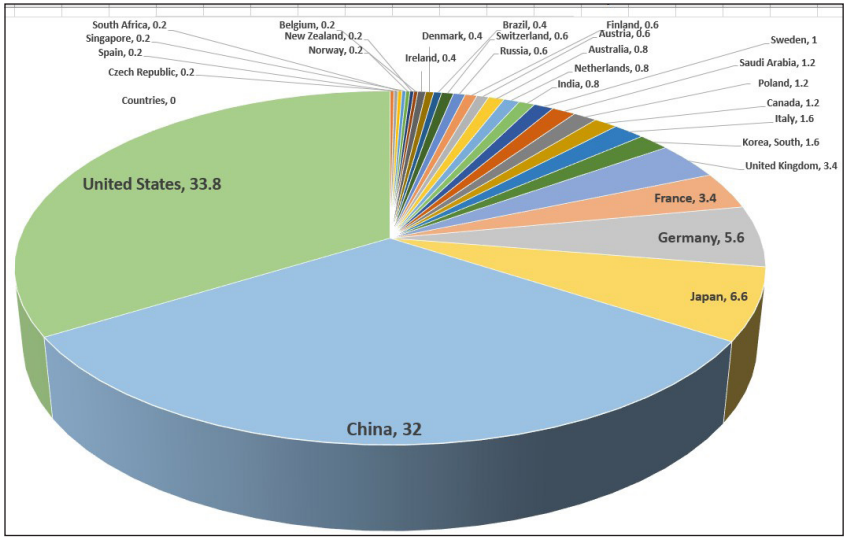

Figure 3: Share of supercomputers in various countries
Source: Top500.org, 2017

The need and rationale for HPC in Africa is self-evident. It is simply unacceptable for a continent of 1.2 billion people to have negligible HPC capacity that is so essential for research, innovation, and development. The African continent faces several socio-economic and political challenges,

scores low on research and innovation indices, and is plagued by the persistent challenges of 'brain drain' with some of the best and brightest people often leaving the continent in search of 'greener pastures', including access to research infrastructures, higher pay and an appreciation for innovation. Nevertheless, Africa is posting impressive economic growth rates and has one of the youngest populations in the world. Technology is making a dramatic impact in Africa and Africa's rate of technology adoption is unprecedented, as is evident in Figure 5. The mobile phone and internet are increasingly widely available.

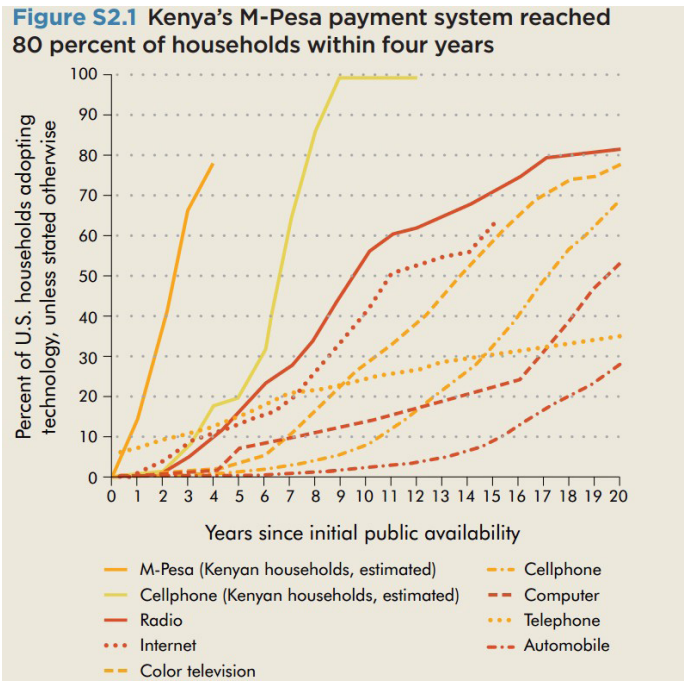

Figure 4: Kenya's rapid adoption of technology
Source: World Development Report, 2016

For Africa to competitively contribute to research and innovation and to find home-grown solutions to its socio-economic challenges, it is important that measures are taken which will provide the continent with access to cutting-edge computing technologies from hardware to software that have become essential for research, innovation, growth, and jobs. Africa must invest in HPC platforms because modern scientific discovery involves very high computing power and the capability to deal with massive volumes of data. Otherwise, the continent will miss out on major advances in research and innovation in the digital age.

It is estimated that a US$ 1 HPC investment on average yields US$ 463 in revenue and US$ 44 in added profit.[19]

HPC can help solve Africa's challenges, such as:

- Climate change: climate research and weather prediction are critical if Africa is to weather the ravages of climate change. Predicting weather accurately can enable countries to make better long-term food security policies, environmental policies, and interventions, and even security policies.
- Health and life sciences: gene sequencing, molecular research and bio-physical simulations can all support the development of effective medicine and vaccines for critical diseases like Malaria and HIV in Africa; and explore Africa's abundance of natural remedies. Epidemic modelling can predict disease spread so that governments and healthcare providers can make appropriate interventions.
- Oil, gas, and mineral exploration: Africa has an abundance of natural resources and access to HPC platforms can speed up seismic analysis which can in turn speed up exploration and exploitation.
- Growth of industry and SMEs: industry and SMEs are increasingly dependent on the power of supercomputers to discover innovative solutions, cut costs and reduce time to market for products and services.[20] Sectors such as retail, manufacturing and financial services could benefit from HPC for data analysis for insights and innovation.
- Economic research: economic modelling using big and open data would lead to insights and contribute to evidence-based policymaking.
- Research collaboration: increase research collaboration between Africa and other parts of the world. Having local capacity for large data processing means African scientists can better contribute to the global research agenda, provide tools for wider collaboration with research colleagues, and stimulate increased awareness, utilisation, and application of HPC in the sectors identified in Figure 1.

It is evident from Figures 1 and 2 that despite the potential of HPC for promoting collaborative research and innovation in various sectors of the world economy, hardly any effort has been made towards harnessing this huge potential on the African continent. There have been HPC initiatives in several countries in the past, including Ghana, Kenya, Congo, Nigeria, Ethiopia, Côte d'Ivoire, Benin, and Cameroon. Clearly, these efforts have not gone far.

There is need to develop HPC technical design and management skills etc., leverage initiatives and build synergy through discussions with potential partners including research programmes, networks and institutions, university communities, associations and institutions, donors, development partners and philanthropists, governments, intergovernmental agencies, and the private sector.

Conclusion

Building digital capacities including information literacy for students at one end and HPC infrastructures on the other end is essential for dealing with the development and employment challenges of today, tomorrow and the day after tomorrow. Digital capabilities and skills are not just good to have, but a must have. They are essential to support effective development of solutions to address societal, scientific, and industrial challenges in Africa, and the development of innovations, products, and services.

This will lead to job creation; augmenting computing capacity that will create new opportunities for both scientific applications and computing technologies; support for growth and competitiveness in industry and Africa's economy through round-the-clock availability and utilisation of HPC systems and services; and enhance South-South and South-North collaboration in education, research, and development.

We invite you to join African universities in this great calling and journey to transform higher education on this continent to educate, skill and empower the youth to fully participate in their countries' socio-economic development. At stake is not only their future, but the future of the African continent and humanity itself, as much of this humanity becomes increasingly African.

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