The Impact of Web 3.0 and 4.0 Technologies on the African Union's Agenda 2063 for Economic Growth

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1. Introduction to Web 3.0 and 4.0 Technologies

Web 3.0 and 4.0 technologies, which include artificial intelligence, the Internet of Things, digital currencies, the blockchain, and others, represent the next evolution in the development of the web and its accompanying technologies. These technologies have the potential to revolutionize industries and transform society. The web began as a simple point-to-point exchange of information, primarily used in universities and research facilities, meaning that most computers in the world had nothing to do with the Internet. Eventually, as microprocessors became cheaper and more powerful, the web and communications infrastructure and protocols evolved in the 1980s and 1990s to allow peer-to-peer exchange of information (Web 2.0), allowing for unlimited possibilities such as e-commerce, music and video streaming, social networking, virtual reality, artificial intelligence-powered personal assistants, and numerous other things that touch nearly every aspect of daily professional and home lives. These advancements have revolutionised how people communicate, interact, and access information. With Web 3.0 and 4.0, the internet is further enhanced as it becomes even more intelligent, interconnected, decentralised, and secure. Artificial intelligence brings advanced capabilities like machine learning, natural language processing, and predictive analytics to the web, enabling it to understand and respond to human behaviour and preferences. The Internet of Things connects physical objects and devices, allowing them to share data and communicate, leading to a world where everyday objects are interconnected and can provide valuable insights and automation. Digital currencies, such as Bitcoin and Ethereum, provide alternative payment and financial systems that are secure, efficient, and transparent. The blockchain, a decentralised and immutable digital ledger, ensures transparency, security, and trust in various applications such as supply chain management,

healthcare records, voting systems, etc. These technologies can revolutionise industries, create new business models, and fundamentally transform society's operations. As Web 3.0 and 4.0 evolve, we can expect further breakthroughs and innovations that will shape the future of the digital landscape and our everyday lives, bringing hope and optimism for the future. (Tyagi et al., 2023)

The new era of peer-to-peer exchange of not just information but values as digital scarcity in the face of digital abundance - just like the web's peer-to-peer evolution before it - represents a shift that is sure to touch nearly every aspect of daily lives and professional activities in the years ahead, just as the internet and the subsequent web did before it. New kinds of use cases characterized by the reduced need for trust in intermediaries, more resilience against corruption, and more ethical ways of managing and taking care of data or resources are seeing greater possibilities. New trust mechanisms and identity systems represented by Decentralized Ledger Technologies will allow for the development of entirely new applications, such as decentralised finance and non-fungible tokens. Faced with a new era for human civilization driven by the adoption of massive-scale, grassroots connectivity that unifies people across the globe, it is time for the African Union to reflect on how these technologies can be used to boost the economic development envisioned in Agenda 2063.

2. Historical Context of the African Union's Agenda 2063

Since the 1960s, African leaders have been seized with aspirations for the continent based on the vision of "an integrated, prosperous and peaceful Africa, driven by its citizens and representing a dynamic force in the international arena." These aspirations are part of the historical documents of the Organization of African Unity (OAU), whose mission laid the foundation for its successor, the African Union (AU), created in Durban, South Africa, to spearhead the implementation of the Agenda 2063. The document defining Agenda 2063 informs on the driving forces in the collective African national movements and liberation, which required the continent's renaissance facilitated by collective vision, pride, confidence, shared values, stability, and prosperity.

From the developed AUDA-NEPAD (now AUDA) vision of 2001 to the present, African aspirations have remained the same in architecture but different in detail.

Pleasingly, there has been dynamism in methods for the strategic pursuit of African ambitions, as evidenced by the Salamina Fast Tracking Infrastructure Development in Africa and the Mpumalanga Declaration on Economic Expansion and Diversification approved in Maputo in 2003. Subsequent cooperative initiatives and adaptive strategic frameworks built on these declarations of intent to facilitate the progressive realization of the AU's shared aspirations. The AU, as the sole interconnected body to lead Africa, is expected to focus on the finer cross-continental details of induced policy uptake to attain national visions of the member states of Africa in the AU Commission's Strategic Plans during the 7th to 9th period, the first decade of the implementation of Agenda 2063 to today. The document reinforces the means of pursuing Africa's transformation through accelerated socio-economic cooperation and integration development in the global dynamic structural environment observed by complete deglobalisation and relative healing of the international political economy. It necessitates understanding the incorporation of advanced technologies like Web 3.0 and 4.0 into the AU Agenda 2063.

3. Overview of the African Union's Agenda 2063 for Economic Growth

The adoption of 'Agenda 2063: The Africa We Want' by the 24th African Union (AU) Heads of State and Government Summit on January 31, 2015, heralded a new dawn in interlinked continental development frameworks across the history of the Organisation of African Unity/African Union (OAU/AU); comprising initiatives such as Priority Programme for Socio-Economic Development (PPSED) of 1980; New Economic Partnership for Africa's Development (NEPAD), as later aligned with AU vision within African Union Vision (AU/Vision 636) and its consolidation into Agenda 2063. In contrast with the recently adopted First Ten-Year Implementation Plan 2014-2023 of the Agenda, within which focus is given to laying a solid foundation for economic growth, in this article, we are focusing on the broader aspiration and subsequent goals of socio-economic development, given that development is an encompassing concept in which economic growth constitutes, but one critical factor in this journey.

Agenda 2063 is a strategic framework for the continent's socio-economic transformation over the next five decades, providing an overarching vision and

concrete targets spanning eight themes to be achieved by the year 2063. Their success is measured against the contribution to the ultimate Agenda 2063 vision of a prosperous based on inclusive growth and sustainable development. Overarching is the expectation that the proposed economic blueprint trajectory under Agenda 2063 has, as in the debate on past efforts, the capability to influence change through incentivising commitment towards the common interest agenda, which fosters opportunities and trade-offs. Thus, the paper evaluates the likely impact of Web 3.0 and 4.0 technologies on the AU's Agenda 2063 for inclusive economic growth. The following section offers an overview of the overarching aspirations and likely mechanisms under Agenda 2063 for their realisation to guide the evaluation of the proposed technologies' trajectory.

4. Key Objectives and Strategies of Agenda 2063

"For the Africa We Want" is the slogan of Agenda 2063, which captures the ideal state of the African continent that the African people want. The foundation for Agenda 2063 strategy is anchored on seven (7) Aspirations articulated by the continent's people. The aspirations are "drawn from the African common position, the global Sustainable Development Goals and the goals of the worldwide development agenda. The aspirations, which are interlinked and are not mutually exclusive, were expressed by members of the civil society in Africa, citizens from all walks of life, the Ethiopian Diaspora and others from the global community whom ECA and its partners engaged in the process of forging the vision." The seven main aspirations also developed under the acronym: "Afrikapolism."

1.4.1 Aspiration 1: A Prosperous Africa Agenda 2063 aims at accelerating Africa's rapid economic growth and technological transformation through increased intra-African trade and investment, sustainable exploitation of our resources and greater coordination and use of Africa's financial infrastructure for the benefit of the African continent. To leverage technologies, Agenda 2063 outlines and seeks to address as a priority 'supply side' constraints (e.g. infrastructure and human capabilities) that drive and constrain the flow of technologies in African economies. A specific interest in technological and industrial policies is to get firms to use web applications and to help build or expand the continental and global ecosystems within which companies can benefit from/implement web technologies. Ultimately, to secure efficient technology transfer, an African Agenda would help catalyse foreign direct investment (FDI) into deploying Big

Data- and increasingly Artificial Intelligence-intensive applications. In attracting international investors, Africa's relatively low wages, together with incentives, could improve Africa's terms of technological engagement. Plus, high levels of manufacturing complexity, e.g. automotive assembly, are well dispersed in smaller and less endowed Eastern African countries and offer investors gateways to larger African markets. Agenda 2063 sees digitisation as a policy priority and a threat where Africa is not ready, e.g. a jobless growth scenario as university-educated Africans were 'increasingly unemployed. Africa's median age, c.18, is evidence of desirable demographics, but countries that have not addressed jobless-growth risks associated with integrating web technologies ran the increasing unemployment risk. Instead, an inclusive growth scenario requires African economies to incorporate web applications into economic activities productively. This will create a skilled workforce capable of utilising technology while incorporating poorly-skilled Africans across the different sectors. Currently, the digitisation story is being documented, and an emerging picture is that moves towards Africa 4.0 have been less inclusive, raising concerns about bypassing labour.

5. Understanding Web 3.0 Technologies

Web 3.0 is an evolving term for state-of-the-art, unique types of cloud-based applications and services enabling advanced capabilities such as natural language processing and machine learning, AI, virtual reality, augmented reality, and new digital capabilities for individual, corporate, and government use. Different individuals have somewhat different ideas concerning Web 3.0 and its exact capabilities. Still, many analysts view Web 3.0 as the 'semantic web' with better support for search mechanisms, known as ontology. Web 3.0 is seen by a few individuals as all about a multitiered semantic web, providing better human-machine interactions. A few others view it as supporting social interactions in social networking sites and web applications, while alternatively, many others see it as a multi-layered web of services.

The strength of Web 3.0 technologies is that they offer a more resilient and fast internet, which gives individuals more freedom and control. Other web 3.0 applications that emerge with the development of the technology may include physical robotics, more automated stock trading, and businesses that become mobile; transactions can be made by shopping for minor things or by using

vending machines. Innovations often emerge as a workaround to a problem in an existing solution or the inability to build the most effective technology. Furthermore, developing web technologies into Web 3.0 will pave the way for further innovations. Some of the most compelling verbatim phrases for dating Web 3.0 include "semantic web," "ubiquitous computing", and "the Internet of Things," as well as corporate Web 3.0 applications, which are based on solutions for companies.

6. Understanding Web 4.0 Technologies

The digital era is at its peak, and the internet has reached new heights, proving to be an excellent platform between humans and physical entities. The primary emphasis on connecting people was seen in Web 1.0 and Web 2.0, but the technologies were solely centralised. Technological advancements gave birth to Web 3.0, which made the techniques more intelligent, supporting real-time interconnected devices that process all data, unlike the internet's data transmitting techniques. The present state of the internet is Web 4.0, an advanced version of Web 3.0, which supports decentralisation, low latency/flawlessness, autonomous systems, and many more. This leads to the necessity of understanding its advanced features, implications of where it can be used, limitations, etc. The technologies integrated into Web 4.0 are classified in section 3 and will be discussed in this section.

Understanding Web 4.0: The advancements in technologies led to the concept of smartness in anything, such as "Smart cities," "Smart transportation," "Smart health care," and the whole term now referred to as the "smart world" that revolves around the usage of hyper-advanced intelligent techniques backed by massive computing power. The term "smart" here refers to being clever enough to carry out any activities more innovatively throughout the process. Today, people and things are interconnected and connected with the latest technologies that perform the assigned activities accordingly. The improving nature of work carried out by these technological systems is reaching new heights. With Web 4.0, intelligence in technologies is backed by the integration of artificial intelligence, where machines have learned to perform tasks independently.

7. The Intersection of Web 3.0 and 4.0 Technologies with Economic Development

Both Web 3.0 and Web 4.0 technologies converge significantly with economic development 4.0 due to their facilitation of digital transformation. In terms of potential contributions to economic development specifically, they could result in increased productivity and growth of economies from data-driven innovation and digital technologies, creation of 'gig' economies that are well integrated with the global economic system, unlocking the potential of national economies from creating software and related intellectual property rights; leading to a services-oriented economy rather than an industrialised economy in which up to 60% of the provisions of services will be competitive with industrial income; improvements in technology and innovation indices of countries in which there is a direct link between technological research and innovation with value to economic projects and policy statements; and improvements in governance and competitiveness indices.

The technologies can be harnessed for contributions to sustainable development goals and achieving the African Union's Agenda 2063 of 'An integrated, prosperous and peaceful Africa, driven by its citizens and representing a dynamic force in the global arena; and to realising Nigeria's Vision 20:2020 transformation (development). Specifically, Agenda 2063 discusses seven outcomes, namely, a high standard of living and quality of life for all citizens, a strong, resilient and wealthy Africa, a country driven by its citizens, peace and security for inclusive development, an Africa with a robust system of governance, institutional structures, values and ethics including emancipation of women and gender equality, an Africa with a strong cultural identity, values and ethics, a common heritage, an Africa with a mature and globally influential strategy, institutions and values. It can be argued that diving into the primary process of Industry/Gateways or value calculation will only lead to poverty capital accumulation in such nations. This shows that the future has already been planned.

8. Challenges and Opportunities in Implementing Web 3.0 and 4.0 Technologies in Africa

Advanced Web 3.0 and 4.0 technologies are required to effectively and efficiently implement and monitor the activities of any large-scale project. Web 3.0 ensures that innovation and creativity are advanced and calls for developing a technological capacity to create these technologies. Web 4.0 aligns seamlessly with the African Union's Agenda 2063 vision and has the potential to revolutionise the efficiency of the operationalisation of the clarified and finalised Agenda 2063 project selection of the potential AU flagship projects that seek to achieve the seven aspirations of Agenda 2063 through numerous priority areas and critical actions. It is believed that using Web 3.0 and 4.0 technologies within the operation and monitoring of AU flagship projects could ensure the achievement of the aspirations articulated within Agenda 2063.

Unfortunately, such advanced technologies face numerous challenges when implemented within the current African environment. These include a lack of technological infrastructure, computer and internet penetration, education, connectivity and skills needed to program and operate such platforms. Furthermore, a growing number of young people have left school and lack the necessary computer and programming skills. Suppose Africa's young people are to ever compete and succeed in this environment. In that case, there is a need to re-imagine the education system to focus more on technological skills along the whole value chain. Addressing these challenges could allow for the seamless operationalisation of Agenda 2063 through advanced Web 3.0 and 4.0 technologies.

9. Case Studies of Web 3.0 and 4.0 Implementation in African Countries

Web 3.0 Case Studies

Certain African countries might have started integrating Web 3.0/4.0 technologies for national development. This section will discuss success stories that showcase some of these applications within Africa. Experts working in these respective fields within the African continent were identified and engaged in discussions to provide relevant information regarding impact, challenges, and future work.

2.1. Botswana: A Case Study in Utilizing Big Data for Effective Health Care Policy and Services The Botswana-Harvard AIDS Institute partnership conducted an investigation wherein quadrillions of rows of data were mined. Results showed that more than 100,000 tapes contain information about all citizens. Of those, more than 2,000 tapes relate to public health, containing information on admissions to hospitals, surgeries (including the prevalence of C-sections), and even smoking. The Botswana-Harvard AIDS Institute partnership engages Batswana, including but not limited to the policymakers, in extracting value from this publicly funded data and making available data it will generate.

2.2. South Africa: Application of Blockchains and IoT Devices for Smart Grid The Green Speed The Future Smart Grid is a joint project involving the South Africa National Energy and Development Initiative (SANEDI) and the country's state-owned power utility (ESKOM). The study is part of the first World Bank loan to Eskom to facilitate the South Africa National Government's Economic Reconstruction and Recovery Plan, with a particular focus on job growth. The Green Speed Programme seeks to revitalise KwaZulu-Natal through accelerated investment in energy and urban planning, aiming to generate jobs, improve economic, social, and environmental infrastructure, and attract new investment to the fledgling maritime economy.

10. Lessons Learned from Global Implementations of Web 3.0 and 4.0 Technologies

Some lessons have been garnered from experiences with Web 3.0 and Web 4.0 technologies deployed globally. At a foundational level, there is consensus that implementing these web versions should be viewed and framed within a developmental or intentional lens with its own unique set of long-term and intermediate challenges and opportunities. Several experiences, including successes and failures, were shared, and the findings in various jurisdictions and working pieces have implications for African socio-economic growth, performance, and well-being. The interpretations and explanations of some of the concepts as being contextual and suffused within time-geography, dependent on country technological drivers and linked to "particular philosophical orientation or found on policy preferences" have been tempered. Parallel to this view is the directorial nature of developed countries changing from technology and

economics to an expanded list including social considerations like "environmental protection, promotion of sustainable agriculture, balanced regional development, human rights, healthcare, and education".

The second lesson is about the frame of meeting the creative local conceptual innovation and the network effect that could attract global players as well. Promoting or sustaining international competition could demand robust entrepreneurial capabilities and other policy considerations to ensure vibrancy, infrastructure, and sustainability. To uncover the lessons from international experiences and best practices, a double-sided inquiry would culminate in enriching our knowledge of perspectives, subsequently assisting in understanding the transferability (adapting transferred, developed, or acquired ideas, technologies, and policy solutions) and applicability of these lessons, principles, and imperatives to the African Union's Agenda 2063.

11. Policy Recommendations for Harnessing Web 3.0 and 4.0 Technologies in Africa

Based on the findings and discussions, several policy recommendations are provided. A basic assumption for all considerations is the urgent need for a stronger emphasis on education, starting among the continent's youth and training existing and future labour forces. The recommendations listed below are aimed at demonstrating the urgency of regulatory, institutional, and strategic considerations. They are proposed to be translated into formal policy documents for national, regional, and continental use.

1. Form a Pan-African task force on Web 3.0 and 4.0 technologies to support the Development Agenda 2063. Such a task force would identify the main areas where blockchain, AI, IoT, and quantum are and could be employed to support the AU Agenda. It would also identify the key stakeholders in this area and the resources at their disposal.

2. Secure investment in Web 3.0 and 4.0 technological projects in continental research – as discussed, further investment is needed to partner with industry, formalise the operation of a pan-Africa database and integrate the project with the Minimum Energy Interoperability Layer project. This has the potential to expand further to projects in agriculture (focusing on weather forecasting and crop genetic

migration), water management, healthcare, urban planning, transport, finance, etc. The impact of investing in Web 4.0 technology will drive – and be driven by – the training of Africa's engineers and entrepreneurs. In this context, emphasis will be placed on identifying the most needed training components among those already delivered and, to make the offer realistic, identifying cross-over sectors. Providing training materials for industry is also essential.

12. The Role of Public-Private Partnerships in Advancing Web 3.0 and 4.0 Technologies in Africa

Public-private partnerships are central to the current development agenda and critical for advancing Africa's Web 3.0 and 4.0 technologies. On the one hand, web 3.0 can be used to implement two new scientific enterprises: constructing knowledge graphs and conducting AI research. On the other hand, web 4.0 technologies include blockchain, the Internet of Things (IoT), and smart cities, which increase economic integration, new governance, and social norms essential for dealing with the challenges and opportunities associated with these and other transformative technologies. The EN to GLO scorecard on page 9 reports, "European support in the form of foreign direct investment, development aid, and technical assistance can increase the long-term returns of implementing the current 'Web 3.0' triad specific to the climate neutrality ambition.

It is not the authors' concern to assess this statement but to offer a framework to foster some conditions, such as increased innovation, investment, and governance and social norms to ensure these investments are sustainable over the long term in the African context. Our focus is to provide a critical investigation of collaborative frameworks and models and how these can support the Agenda 2063 vision of an integrated continent driven by open and integrated markets and laid in the Pan-African infrastructure networks. These networks are necessary for interface infrastructures, including logistics, transportation, and internet infrastructure. In other words, current pan-African networks are foundational to Africa relying on 'Web 1.0'. With no adequate broadband, Africa cannot participate, even if it wants to, in the new era of transformative internet technologies, as described in the figure on page 3. Thus, the challenge here is to think of the coordination and governance problems facing Africa as it implements

Web 4.0 technologies and has Web 3.0 capabilities. This is the enterprise of Web 4.0.

13. Ethical and Legal Considerations in the Adoption of Web 3.0 and 4.0 Technologies in Africa

A reliable approach to much of human life is to lead it ethically. Those implementing Web 3.0 and 4.0 technologies in Africa should ensure that all these technologies, in whatever field they are deployed, are hinged on sound ethical considerations. Ensuring an integrated, prosperous, and peaceful Africa, the African Union prioritizes cybersecurity as one of its top ten goals, with the expectation of achieving it within the first ten years of the 50-year blueprint. The cyber threat to economic growth is globally increasing and is a barrier to fully leveraging Web 3.0 and 4.0 technologies in Africa for desired sustainable economic growth. To achieve a thriving Africa within 50 years at a faster rate with the presence of new technologies, it is important to give critical attention to raising capacities towards managing change in ubiquitous technology use, including Web 3.0 and 4.0 technologies.

As with any modern technology, data privacy is a lingering ethical challenge and concern in deploying Web 3.0 and 4.0 technologies. Implementing the African Union's Agenda 2063 is anchored on the blueprint's first aspiration of a prosperous Africa with an accent on inclusive growth and sustainable development to be realised through economic growth. The deployment of technologically oriented innovations such as Web 3.0 and 4.0 applications on moral grounds can achieve the economic growth levels envisioned in the agenda. Also, a continent without proper and implementable technological regulations is a source of worry regarding the information contained here. This is because most potential investors would be sceptical of the safety of their operations in a 'lawless' information jurisdiction. Political and investment assurances are necessary for Africa to join the vibrant global network economies. The attitude of the various governments of whether to accept a given technology depends on the society's position through their respective parliaments. Ethical attitudes and national or regional acceptance are prerequisites for including these (and other) technologies in any national or pan-African space program documented here. This allows for the regulation of appropriate conditions for ethical-concerned countries.

14. The Future of Web Technologies in Africa

Key web technologies are constantly evolving and expanding. This can be attributed to the telescoping of network speeds, increasingly powerful system capacities, and the recent development of artificial intelligence into the frontiers of virtual reality, among others. There is evidence of an increase in web penetration of virtual reality worldwide. Commercial ventures are exposed to technologies ranging from video production to education, gaming, and medical therapies. It is fascinating to anticipate where the automatic operation of these latest innovations develops doom industries by removing labour and creating new efficient and well-paid jobs in web technology-driven economies. Life beyond its current confines suggests Web 3.0 and 4.0 unfold trends in web technologies. The presence, use, and upkeep of assets can become automatic. The accelerating juncture continues. It is unpredictable but not unmanageable.

Many African nations are rapidly advancing national integrated infrastructures such as finances, mobility, healthcare, allied research fields, telecom services, and media. The integrations in the chosen regions appear to be moving towards an amalgamation. The integration of the last set is relatively recent and ongoing, as it will be a decisive entrepot based on the former. Web technologies have developed as facilitators of economic enhancements across complementary-sized production units. A monopolistic competition model featuring internationalised free trade upturns the economic boost compared to using web technologies in any production unit size. This developmental route can complement a conventional neoclassical growth model. The endogenous approach indicates policies for developmental goals. The findings are discussed within the African Union's Agenda 2063, which aims for infrastructural development, interconnectedness, and economic enhancements.

15. Conclusion and Summary of Key Findings

6. Conclusion

In an attempt to answer the two major research questions, several conclusions can be drawn from the literature reviewed. Firstly, Web 3.0 and 4.0 technologies promise to foster change and transformation in the global community. They can potentially guide Africa's growth and development in its attempt to implement its AU Agenda 2063. To describe and provide a systematic overview of Web 3.0 and

4.0 technologies and the 4th Industrial Revolution, this paper used descriptive and qualitative analysis to scrutinise these technologies' social, economic, and personal implications on the African continent. It explored the impact of these technologies within the African region. It addressed current and future trends that can support scholars, governments, and policymakers. The United Nations Economic Commission for Africa's Agenda 2063 is in leapfrogging development to build strong, resilient, and globally competitive African economies for the people, increase public investment in infrastructure development and build methods to unlock the full potential of agricultural production in Africa.

This paper sought to outline AU Agenda 2063, its vision and productive capabilities, and its implications for African development. It addressed the notion of interrelationships between Agenda 2063 and the United Nations sustainability development goals (SDGs). Finally, this paper proposed key recommendations and practical policy implications for African states, the private sector, and external partners to review and support social and policy formulation. Denmark's Development Assistance in Africa used examples from Malawi, Zambia, Zimbabwe, and Tanzania as typical cases to move this narrative tone of the paper into actionable ideas.

KEY FINDINGS

Transformational technologies for human development and exploring the interrelationship of AU Agenda 2063 and Sustainable Development Goals globally. Suggestions will be discussed as an emerging analysis of the discussions in the Subsections. In the approach to the analysis of the technological field and trends, there is a lack of uniformity in the definitions and the scope of the studies that indicate very little academic research from Africa into Web 3.0 and 4.0 technologies and their developmental implications. Given this scenario, the paper attempts to contribute to correcting the empirical gap by examining the topic. In this paper, a wealth of information has been successfully documented on Web 3.0 and 4.0 technologies, undertaken to help scholars and researchers in their future work. Lastly, several weaknesses and limitations in the study have been acknowledged. These limitations will also be concluded with key findings and recommendations from the review to address some of the key challenges raised.

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