Review

Prognostication Opportunity of Future STEM Education and 4IR for Africa: Uphill Massif

Tola Bekene *

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Prognostication Opportunity of Future STEM Education and 4IR for Africa: Uphill Massif

Tola Bekene

Wachemo University, Ethiopia; leencaoro@gmail.com

Abstract: The broad adoption of information and communication technology and the shift to a fully digital society are together referred to as the "digital revolution." Similar to how the first industrial revolution affected western nations in the 19th century, the digital revolution has the power to drastically develop and transform Africa. The majority of African nations, if not all of them, are still searching for answers to the political, social, and educational issues that their citizens deal with. The principal objectives of the research were to ascertain the obstacles and possible patterns in African nations concerning the execution of STEM education and 4IR across the region, in addition to offering a plan and approach for doing so. In order to explore the sought papers and find answers to the research questions, the study employed the archival research study process. The results show that certain patterns that were adopted in Africa must be cooperatively adopted throughout the continent.

Keywords: Africa; archival research study; STEM education,4IR; trends and challenges of Africa

1. Introduction

In order to prepare for the Fourth Industrial Revolution (4IR), the educational system in many wealthy countries has changed, while in others the changes are just now being made. The introduction of Science, Technology, Engineering, and Mathematics (STEM) education to African higher education students is a step toward reterritorializing education in the context of the Fourth Industrial Revolution. With the emergence of the Fourth Industrial Revolution (4IR), rapid developments in science and technology have greatly affected everyday life. In the education sector, developments such as the Internet of Things (IoT) have influenced curricula and introduced educators to new teaching methods with the combination of well-developed model of teaching and learning [e.g. ASSURE model and Cycle Model developed by(Bedada, 2021)] and promoted by indigenous knowledge(Oyekunle, 2021). In this context, 4IR is expected to actualize smart education environments that can improve the quality and accessibility of education. Corresponding to 4IR, we have education 4.0 that developed for adjusting traditional curricula familiar with IoT. This calls for an increased emphasis on mathematical skills such as critical thinking, problem solving, communication, collaboration, and innovative thinking(Alakrash & Razak, 2021). The mathematical skills such as critical thinking, problem solving, communication, collaboration, and innovative thinking can be improved by using technology within the classroom(T. B. Bedada, 2021). This concept goes with the internalization of curriculum/lesson plan(please see stages of cycle model) that need to be deterritorialised [loss of territory] and which can be ensured by student engagement(Fomunyam, 2020). In addition to this, one of the force tasks of doing this is the role of teacher and students [scaffolding stages of cycle model]. Moreover, the teacher training courses need to shaped to improve practices and education in the teaching and learning relationship by ***delocalization*** and ***spatialization*** classroom in which students are become reflective and protagonists of their cognitive and intellectual growth(Augusto Couto Barone et al., 2016). For this to happen it needs a collaboratives room/site/center of innovation known as STEM curricula. The STEM education process involves curriculum change and teaches students four distinct disciplines: science, technology, engineering, and mathematics that incorporates an interdisciplinary and practical approach and occasionally integrates the arts(Bedada & Machaba, 2022a). (English, 2015, p. 1) says

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that Climbing Mountains, Building Bridges is a rich theme for exploring some of the "challenges, obstacles, links, and connections" facing mathematics education within the current STEM. To the above concepts end,4IR and STEM education have relationships in such a way that 4IR is the stages while the STEM education is the curriculum reforms can be reformed depending on the stages of 4IR accordingly to produce cultivated society(T. B. Bedada & Machaba, 2022a). Artificial intelligence (AI) culture to the cultivation of Augmented Humanity (AH) and as a result now adays within 4IR society 5.0 were cultivated.

2. Statement of Problem of the Study

Everyone is concerned about aspects of 4IR, but no one bears ultimate responsibility at this time. (Morgan, 2019). Those working in STEM fields are more likely to identify as scientists, engineers, or mathematicians than as technologists. (McComas & Burgin, 2020). However, within the area of 21st century the technology is the word that tied to the society to answer the human made or nature created problems in the community of 4IR. The Fourth Industrial Revolution (4IR) is outgrowing including the introduction to ***artificial intelligence, advanced robotics, block-chain, drones, internet of things, wearable technologies, cloud computing technologies, 3D printing, Big Data, machine learning,*** and software-enabled industrial platforms and outliving the Third Industrial Revolution, and it has implications for higher education in Africa and in general because of the anticipated impacts of the Fourth Industrial Revolution (4IR) on people, nations, and the entire planet, preparations for the 4IR are still being made on a worldwide scale. The 4IR is the current and developing environment in which disruptive technologies and trends are changing the way we live and work. However, the behavioral intentions of individuals to accept and employ disruptive technologies play a major role in the effective implementation and adoption of new technologies(Machaba & Bedada, 2022; Thoti, 2024). 4IR comes with high digitization and (Mkwanazi & Mbohwa, 2018) formulate the causes of 4IR to happen by stating that rapid increase and exposure of people to radical techno-economic solutions can resolve their daily challenges. Mobile supercomputing, intelligent robots, self-driving automobiles, genetic editing, and neuro-technological brain improvements are a few of the elements of the 4IR. If substantial consideration is not given to the 4IR, higher education in Africa risks falling behind(for instance the occurrences of Covid-19), and the digitization that it comes to (Fomunyam, 2020; Mamphiswana & Bekele, 2020); with more specifically, Ethiopia. Moreover, STEM education in Africa is falling behind when compared with the rest of the world. The African Development Bank has reported that less than 25% of African higher education students pursue STEM-related career fields, with more students pursuing social sciences and humanities. With the appearance of Covid-19, most of the universities in the world shut down their teaching and learning most largely in African countries to reduce the distribution of the diseases. The universities involved in online teaching and learning processes are the best universities that answer for reducing the Covid-19 distribution as they run their teaching and learning process online within the Covid-19 period. For, instance the UNISA. The 4IR entails the integration of technology, humanity, and biology(Mathekga & Sekudu, 2019). However, review literature reveals that schools that do teach the four STEM disciplines often do so in a disjointed manner, failing to integrate STEM in a unified way(McDonald, 2016). (McComas & Burgin, 2020) advice by saying that for the purpose of avoiding confusion on the process of teaching STEM education, it is possible to teach one of the elements of STEM referred as STEM education and can teach students by integrating the elements of it together and named it as I-STEM. This study is motivated by this gap, it aims to bring to light challenges faced by Africa and offer some insights to guide the development of credible corridors for policy makers and researchers for developing African countries and forecast how to develop tools to mitigate future anticipated challenges of Africa.

3. Objectives

The objectives of the study were coined within the following concepts.

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a. To investigate the trends of Africa on the implementation of STEM education and 4IR in their education system at higher education.
b. To elaborate on the challenges to Africa that hinder to implementation of STEM education and 4IR in their education system at higher education.
c. To suggest the future supposed gate/path/ of Africa to be familiar with the STEM education and 4IR in the education system at higher education.

4. Research Questions

a. What are the trends of Africa with the implementation of both STEM education and 4IR in their education system at higher education?
b. What are the challenges and opportunities for Africa to implement STEM education and 4IR in their education system at higher education?
c. What are the future supposed gate/path/ of Africa to implement STEM education and 4IR in the education system (forecasting of the matter)?

5. Significance of the Study

In order to address the challenge that occurred in Africa, particularly Ethiopia, this insight paper strongly advocates for the causality challenge and highlights the moral obligations of academia, government, and industry. It also forecasts Ethiopia's future educational system in the context of 4IR and STEM education.

6. Review Literature

The reviewed literature this divided into three categories to answers the research questions of the study. These are searching about 1) Trends of implementation of STEM education and 4IR in the education system in Africa 2) Challenges to African countries that hinder to implement of STEM education and 4IR in their education system 3) future of African countries to implement STEM education and 4IR in their education system.

1.1.6.1. Trends of Implementation of STEM Education and 4IR in the Education System in Africa

In this section, we need to define the term revolution and paradigm. The two terms are defined by the known scholar Thomas Kuhn to mean gradual changes of science and world views respectively in the world(Kuhn, 1996). Kuhn argued that a scientific revolution is a non-cumulative developmental episode in which an older paradigm is replaced in whole or in part by an incompatible new one. Over the past few decades, the world has experienced multiple industrial revolutions, and each one has had an impact on the nation's educational system(Deliwe, 2021). 4IR has become the driving force for integrating technology in the classroom instruction for improving higher education worldwide. Not just in science but in every aspect of human existence, revolutions take place. In science education and related fields, the potentially revolutionary times concerning various proposals for STEM education were emerged and will emerge also. STEM education is the basis of the appearances of 4IR(Mkwanazi & Mbohwa, 2018) and can be considered as a site(Nxumalo & Gitari, 2021). As to Ethiopia, it is named as the center.

To this effect, in South Africa, one university was found to have made significant progress in training 4IR skills for industrial engineers(Kayembe & Nel, 2019). In the same fashion, in Rwanda, engineering education has provided skilled personnel for industry and solutions for local development problems and the Swedish university boosts the human power(considered as the benchmark) and quality of STEM education in African countries are poor (Ismail, 2018). Hence, to us, as STEM education is the base for 4IR and STEM is not a novel topic, as the concepts have been promoted since 1990,4IR is also poor in African countries and the indicator of this assertion is that

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Africa has started its digital transformation by the end of the 1990s where it has begun by the mobile or telecommunications revolution(Adam, 2019; Ismail, 2018).

As to the 4IR, STEM education does have some revolutionary character(McComas & Burgin, 2020). To this end, new proposals were given as mixing a topic such as art into STEM to create STEAM. (Aguilera & Ortiz-Revilla, 2021); or combine STEM with law to create STEMLE; or combine STEM and reading to create the hybrid STREAM (McComas & Burgin, 2020, p. 817). They also fear the problem arises because of teaching students by merging engineering and sciences in the classroom while they reviewed their literature, however, concludes as the "links between science elements of mathematics, engineering, and, perhaps to a lesser extent, technology may be helpful" (p.825). Moreover, in developed countries for instance "various US cities, schools labeled as failing are being repurposed as selective STEM-intensive academies to build a STEM education infrastructure"(C. Bullock, 2017). STEM is an educational methodology that is now accompanied by the STEAM the combination of STEM and arts[in terms of student's creativity within the classroom and outsides of the classroom(T. B. Bedada, 2021; T. B. Bedada & Machaba, 2022a)] modification(Aguilera & Ortiz-Revilla, 2021). However, some scholar starts with a question to define STEM as "Is STEM a new teaching approach or a philosophy?" In the author's words,it's possible that this is due to the lack of widely acknowledged definitions for STEM education and the lack of specific ways for implementing them (Bybee, 2010). Bybee (2010) explains that when children ask questions about how tools, equipment, or anything else we use works, what advantages technology brings to our lives to make it function, and how to motivate them to be intrigued, STEM is being taught correctly. Depending on the literature, STEM is coined in the 4IR. Moreover, it known that engineering is directly involved in making innovations and solving problems. In addition the scholar(SARICA, 2020) claims that STEM education, which combines science, technology, engineering, and mathematics, is a comprehensive strategy that is becoming more and more popular and is crucial for nations to compete and stand out in the 21st-century global economy. This expert disagrees, arguing that STEM education is only used in the United States of America (USA) and that STEM curriculum reform is used in many other countries.(Lai, 2018).

Many countries are increasing their attention on STEM in schools and the workforce, with its important significance across numerous industries becoming explicitly recognized(English, 2015). Having a problem of understanding and implementing STEM education in the classroom some organization tries to establish a center known as Experimento and STEM power and prepare Forum [PASET Forum]. Here, I am interested to discuss the trends of the three ideas such as Experimento and STEM power and preparing Forum [PASET Forum].

Figure 1. Countries implemented Experimento in Africa and continent in the world.

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Experimento is founded on the idea of inquiry-based learning, which views kids and teenagers as active participants in their education. They ask questions, use a variety of techniques to find answers, consider what they've learned, and compile the findings on their own. The young researchers discover that their efforts result in achievement, which is an important and inspirational lesson that increases a child's self-confidence. It also implies that education is not confined to the classroom and that learning should be applied to real-world situations, reexamined material, and generated outside of the classroom. The course of study Experimento is more than just learning science and technology; it was designed with values in mind in collaboration with Ludwig-Maximilians-Universität (LMU) in Munich. Age-appropriate, multi-tiered STEM classes that emphasize cooperative learning, problem-solving techniques, and the capacity to take action should be centered upon social and personal values. Conscientiousness and activism for the environment, the natural world, and a sustainable future are examples of societal values that are promoted.

STEM power provides hands-on STEM enrichment in sub-Saharan countries such as ***Ethiopia, South Sudan, Kenya, Tanzania, Somaliland, Cameroon, Ghana, South Africa, and Zimbabwe***. Of these countries, I am interested in dealing with STEM power in Ethiopia trends. STEM power in According to STEM power, Ethiopia has made every attempt to advance STEM education in order to empower women and produce a new generation of young people who can solve problems. For the benefit of thousands of bright engineers and scientists who have the opportunity to present their inventions to both the country and the globe, STEM power and the Ethiopian Ministry of Education have been collaborating on the national competition. For Ethiopia, the issue of youth unemployment has been quite problematic. According to the country's Job Creation Commission, there will be a 14 million job deficit by 2025. This has led to the creation of a national plan aimed at fostering a thriving private sector by providing assistance to medium-sized and micro enterprises. STEM power has made numerous attempts to create jobs. For example, STEM Power and VISA, the global leader in digital payments, have partnered to support Ethiopia's ambition to create jobs by helping young innovators launch and expand their technically focused small and medium-sized businesses.

Discussion on the 5th PASET FORUM Africa country intends to do the following actions to accomplish 4IR(PASET Forum, 2019): -

a. From the ***Ethiopia***n government
   - There has been an expansion of the TVET sector and growth in higher education institutes in Ethiopia.
   - An enabling ICT policy with institutional arrangements to implement is important to have an ICT-driven country as well as a knowledge-based economy.
   - Ethiopia is currently well connected in terms of coverage and several sectors are adopting digital technologies from agriculture to finance. However, TVET schools and some universities still have poor connectivity.
   - There is a national depository system for educational materials as well as digital libraries in some universities. Several digital courses (e.g., from author observation Mathematical software for Mathematics students was added, etc.) have been added to curricula and all students take a course in emerging technologies (for freshman Ethiopian university students) to prepare the youth. Universities also have incubation centers.

To sum up, the speaker from Ethiopia on PASET FORUM did not say anything about 4IR directly. Ethiopia is limited in its ability to implement and develop the fourth knowledge wave(Kim, 2020).

b. From the ***Guinea*** government
   - There is political commitment to keep up with the 4IR.
   - Guinea has formed the Guinea Technology Valley that emulates Silicon Valley.
   - Guinea is promoting a technology-led education system hence several reforms are ongoing: key sectors like agriculture and mining are being focused on for digital transformation; fiber

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optic is being laid out across the country; training programs are being initiated in various sectors; curricula have been adapted to match companies' needs; all high schools have electronic communications, and there are virtual libraries in some universities.

- Challenges in the country include access to wide-scale internet, human resource issues, and funding

c. From the ***Tanzania*** Government

- Several initiatives such as an ICT policy and corresponding pillars for infrastructure, human capital development etc. have been introduced.
- The government has laid 7500 km of fibre optics and an additional 20,000 km will be built to cover the last mile solution.
- Curricula are being revised to reflect the needs of the 4IR, such as IoT, AI as well as 3D technologies in TVET. e-Libraries have been established from primary to higher learning institutions.
- Connectivity has been improved in higher learning institutions using the Ubuntu service.
- Challenges that the country faces include human capital capacity and funding. The way forward involves increased collaboration, charting new ways to get funding and reviewing the policy roadmap for the 4IR.

d. From the **Rwanda** government

- Human skills are critical to leverage the 4IR and Rwanda has placed a great deal of effort in this area considering the country's history where education was segregationally based on ethnic backgrounds.
- Education and training are considered as the main driver for Rwanda's development. Several policies and initiatives have been put in place including initiatives to promote new pedagogy and assessment required by the 4IR, promotion of Science, Technology, Engineering and Mathematics (STEM) programs and enhancement of English language proficiency.
- University of Rwanda has been reformed and merged to raise academic quality as well as to avoid duplication of resources. The same merging policy has also been enacted in TVET colleges which have been merged into Rwanda Polytechnic.
- Rwanda has been getting ready for the 4IR since 2000.
- The journey started with the formation of an ICT policy and institutional arrangements, hard core infrastructure such as fibre optics, use of secured and shared infrastructure, and finally implementing the Smart Rwanda master plan. Currently, the Rwanda Coding Academy has been launched to address readiness for the 4IR.
- Rwanda has established a regulatory framework as an enabler for digital transformation. There is a need for smart and dynamic regulations and guidelines. With the 4IR, change is rapid and hence, there is a need for continuous revision.
- Efforts are being made to provide flexible guidelines in cybersecurity and data privacy.
- Rwanda is active at the international level in standardization issues related to the 4IR.
- There are special provisions for companies in critical sectors such as transport by issuing licences.

In general, the countries involved on PASET Forum talked about the understandings of 4IR, on the challenges and opportunities in the ***past, past in the present, future, and future in the present*** directly except Ethiopia.

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6.2. Challenges and Opportunities to Africa Countries that Hinders to Implement STEM Education and 4IR in their Education System

6.2.1. Challenges to African Countries

One common issue in many African nations has been the accessibility of 4IR technologies. The cost of devices and connection services like the internet, as well as the caliber of the connectivity infrastructure, are frequently linked to access problems. The digital gap is a result of extremes in access to technology, typical for individuals living in towns and cities compared to the bulk of those living in rural areas.

With the development and deployment of new technology, the 4IR has its own set of risks. According to (Schwab, 2016), it is unknown how the 4IR will manifest, but one certain thing is that a response to it must be coherent and inclusive of all interested parties in the nation's institutions, ranging from business and public sectors to educational and public society. It takes careful planning to mitigate these hazards. Additionally, new procedures and systems for risk management will need to be put in place. This suggests that emerging technologies have the power to improve the way people live. The world must not, however, ignore the risks and downsides of these recent advancements in technology. According to (Kayembe & Nel, 2019), inequality and income distribution are among the risks associated with 4IR for education among South Africans, and they also forecast that STEM curriculum should be reconsidered as a new method in 4IR.

Many African countries have limitations to develop even though they have 'latent comparative advantages' because of no infrastructure for 4IR(Kim, 2020). Africa's continued challenges with availability and affordability of bandwidth and noted that this is the time for Africa to catalyse its transformation through the utilization of 4IR technologies, which will entail reforming the education system, and strong leadership and commitment(PASET Forum, 2019).

One of the elements of 4IR is IoTs which deals with is a novel paradigm that is rapidly gaining ground in the scenario of modern wireless telecommunications. Ethiopia, on the other hand, currently only has the infrastructure to use basic to intermediate cloud computing applications (internet) (e.g., email, web browsing, and video conferencing) (Banga & te Velde, 2018). Ethiopia's sector faces additional hurdles from irregular electrical supplies, logistical impediments, and illicit activities. ICT is generally in its infancy in the majority of African nations(Barakabitze et al., 2019). The issues that arose in South Africa's higher education were inadequate use of technology, weak reasoning and logic skills, and low reading and literacy skills(Yande, 2021).

Due to deficiencies in its educational system, which restrict the availability of managers, inadequate infrastructure, which reflects weak governance, and state capture, South Africa suffers from a severe skills shortage that affects researchers and workers needed for 4IR (Sutherland, 2019). Generally speaking, developing nations have not been able to fully benefit from the first three industrial revolutions due to a variety of circumstances, including geography, governmental structure, and a lack of infrastructure and technical know-how(Ally & Wark, 2020). Particularly when it comes to implementing policies across departments, it has a dismal track record. There have also been noticeable delays in cybersecurity and data protection. Hence, the lack of STEM education in Ethiopia is the problem of implementation strategies, lack of a national scheme, uneven implementation, and variations in the creation of STEM education centers (Tamrat, 2021).

The examination focuses on the disruption of societal values and restructuring of the economy, poor infrastructural development, lack of skills capacity to integrate new technologies, fear of losing jobs, poverty, and inequalities that threaten the success of the implementation of 4IR(Shava & Hofisi, 2017; Yande, 2021).

Though notable and swift technological progress holds promise for bettering human lives, it also gives rise to anxieties about the future, particularly for those seeking employment(Morgan, 2019; Zervoudi, 2020). One of the biggest fears related to the new technologies is that robots and artificial intelligence will replace the human factor in work leading to "technological unemployment"(Zervoudi, 2020, p. 1). This is not the first time that technological advancement has been viewed as a danger to people's jobs.

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6.2.2. Opportunities to Ethiopia

Following the election of Prime Minister Abiy Ahmed (Ph.D.), Ethiopia's government implemented a homegrown economic growth policy centered on the privatization of state-owned businesses, including hotels, industrial parks, sugar development plants, railroad projects, and other manufacturing industries. The decision was also taken to partially permit minimum shares in state-owned businesses, including the Ethiopian Shipping and Logistics Services Enterprise, Ethio-Telecom, Ethiopian Airlines, and electricity generation projects. The availability of new technologies and the political will to test them out indicate that there is a present high level of interest in and spending on technology for education. Ethiopia is among the nations where education requires technology in order to lead to wealth in the eyes of the government. The newly established Artificial Intelligence (AI) Center, one of 4IR, for example, recently signed Memorandums of Understanding with five institutions (including Zewditu Memorial Hospital, Addis Ababa Institute of Technology, Addis Ababa Science and Technology University, National Meteorology Agency, and Oromia Cooperative Bank) to collaborate on the development of artificial intelligence products and services that will improve the public's protection and safety as well as the health, education, agriculture, and transportation sectors. It is clearly identified without research that the environmental disaster by itself forces the world to use the technology. Even though Ethiopia is one of the countries that are facing with many problems on the implementation of 4IR, the Ministry of Education (MOE) has begun projects to improve and introduce technology to alleviate chronic problems faced in the educational sector. As to the Ethiopian government, 4IR is the revolution that can solve a society's problems, for example in the educational sector. The following figure indicates how the project aims to transform Ethiopian educational sectors.

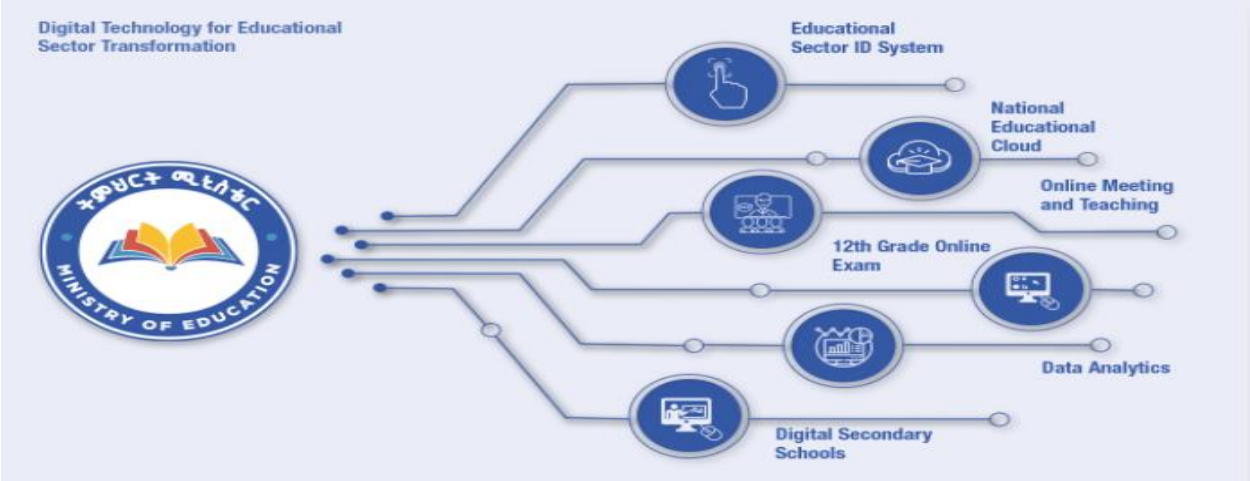

Figure 2. Ethiopia Digital Technology for educational sector transformation (adopted from MOE, Ethiopia web pages).

In addition to this, the Ethiopian government identified the problem of a country's education system and developed a new education system known as the Ethiopian educational road map which aims to cultivate a society of the 21st century(Teferra et al., 2018).

6.3. Future and Future in the Presence of African Countries to Implement STEM Education and 4IR in their Education System (Forecasting Matter)

The best method to grow an industry or society utilizing technology is to use their technology and experience(Kim, 2020). Agenda 2063 of the African Union aims to achieve equitable growth and sustainable education programs that emphasize innovation, science, and technology, so ensuring a skills revolution. The African Union's Continental Education Strategy for Africa (CESA) seeks to address this issue by transforming the continent's systems of education and training in order to provide knowledge, skills, innovation, and creativity that are appropriate for the continent's

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socioeconomic development. Because of this, African nations are enhancing and broadening the reach of excellent educational opportunities, utilizing the potential of their training programs, harmonizing the management and integration of education, and bolstering their STEM (science, technology, engineering, and math) curricula. This entails advancing scientific literacy and fostering a science-friendly culture inside African communities.

6.4. 4IR for Emergency in the Education Sector

With the advent of Covid-19 and its impact on other industries, including manufacturing and services, education there is little question regarding 4IR's benefits to the education sector, including hiring, training, and learning(Oke & Fernandes, 2020). The interactive aspect of technology plays a bigger role in 4IR's contribution to teaching and learning, yet existing solutions like projectors, LCDs, and blackboards can still be useful. A range of 4IR instruments were released from basic school to higher and tertiary education in South Africa during the period of lockdown, while educational activities shifted to remote (online) learning(Mhlanga & Moloi, 2020). These findings show that there are generally some excellent areas in South Africa that can propel the education industry into the 4IR compare to Ethiopia as a country, perhaps expanding access. Compared to South Africa, Ethiopia is a country that faced many problems in the education sector as the country is not ready for employing 4IR(T. B. Bedada & Machaba, 2022b). The government recommends teachers and students use telegrams during the occurrence of the Covid-19. In general, to my understanding, as Africans are new to the implementation of 4IR and starting to implant STEM education in the education center because of the challenges indicated in section 6.2.1, the continent should prepare to take revenge for the problems the world brings to them.

7. Theoretical Underpinning

Numerous theoretical models explaining people's intention to use technological breakthroughs have been developed as a result of research on user acceptance of new computing innovations. These frameworks have their theoretical roots in sociology, psychology, and information systems. Several frameworks, including the Unified Theory of Acceptance and Use of Technology framework, were employed by me to study(Venkatesh et al., 2012), and the use of identification of the environment in the cycle model. Several frameworks have been employed to investigate individuals' acceptance and utilization of technology, such as the Theory of Diffusion of Innovations(Rogers, 2003), the Technology Acceptance Model(Davis, 1989), and the Unified Theory of Acceptance and Use of Technology(Venkatesh et al., 2012). To address the absence of a theory to guide effective integration of technology in education, the Technological Pedagogical Content Knowledge (TPACK) framework was developed by(Mishra & Koehler, 2006). To this effect, the cycle model was developed by(Bedada, 2021) that considers the environment itself on the first hand for integration of technology into the classroom teaching and learning. According to the model whatever the types of technology that are comfortable for the learning and teaching process, the identification of the environment should be there. Hence, for instance, in developed countries, the implementation of STEM education and 4IR is easier than in developing countries(Oyekunle, 2021).

8. Research Methodology

8.1. Research Design

An archival research study methodology was used for this investigation. Reviewing previous research papers from a certain time period that satisfy certain requirements is known as archival research(Ventresca & Mohr, 2001). In this paper, I used an archival study to investigate a relatively new area of research and to propose underlying themes for future research on 4IR and STEM education.

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8.2. Review of Existing Research: Criteria and Procedure

The study purposively selected the sub-Saharan countries those running STEM power currently such as ***Ethiopia, South Sudan, Kenya, Tanzania, Somaliland, Cameroon, Ghana, South Africa, and Zimbabwe*** of these more attention was given to both ***Ethiopia and South Africa*** as the authors of the articles are from the two countries and four countries were also selected from PASET forum (2019) such as ***Ethiopia, Guinea, Tanzania, and Rwanda***. The researchers directly search the articles published by the author of the countries on google scholar (scholars' publication) and google (published by the government in the year of 2021 calendar) platform on their education system by using the specified database.

For each participant of the study the researchers have used implementation of STEM education and 4IR, challenges and opportunities of implementation of STEM education and 4IR; and future of STEM education and 4IR as key term searching engines for each selected country. A desktop literature study approach was followed to assess the data for answering the research questions of the articles. Journal articles were sourced from online academic databases including Mendeley, African Journals Online, Google Scholar, Unisa library, and Direct Google were systematically searched to identify primary studies.

8.3. Analysis and Quality Assurance

Given that this work serves as a roadmap for future investigation into the relationship between STEM education and the 4IR, the quality of its analysis must be exceptionally high. Archival research procedures will form the basis for the analysis of the papers that were sourced for this endeavor(Ventresca & Mohr, 2001). The article's length and relevance are usually used as the foundation for analysis. The quality assurance process is a sequential process that comprises the following steps: (1) finding pertinent articles for STEM education and 4IR; (2) going over each article; and (3) determining which articles qualify or disqualify for further study. (4) verifying the essential details of the selected (qualified) piece and (5) compiling the analysis using all the articles that made it past the quality control inspection for this investigation.

9. Discussion and Findings

9.1. Curricula: Trends to be Implemented in Africa

The level of education of a nation determines the level of development that is experienced. The study finds from the review literature on the trends of the implementation of STEM education and 4IR in schools in Africa. The trends are Experimento and STEM power and prepare Forum [e.g., PASET Forum] in which African countries are working together to implement STEM education and 4IR or which lessons can be learned from each other in the continent. Some university in Africa starts training to skill up their students with the concept of 4IR(Kayembe & Nel, 2019). This trend should be expanded throughout the continent to compete with western countries, especially in Ethiopia.

9.2. Challenges of Africa to Implement STEM Education and 4IR:(SIB Challenges)

The study finds three major challenges as factors of STEM education and 4IR implementation in the continent. These three broad factors are ***human skills***, ***infrastructures***, and ***Resources[budget]*** *or in short* ***SIB*** *factors* which align with the findings of (Kayembe & Nel, 2019). According to some academics, the number of job seekers not only in Africa as a globe has increased as human labor is replaced by machines, and some jobs are offshored because of ***robotization, autonomous driving, dematerialization*** which may be considered as a factor(Kim, 2020).

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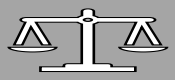
Themes	Factors
Human skills 	Supply of managers Weak of governance Capture research Governance structure Technical experts Implementation strategy Pedagogical adaptation Teacher development
Infrastructures 	Location [e.g., Africans and Western countries] Supply electricity
Budget 	Inequality Income distribution Funding
Fear of Loss of Job 	Human resource replaced by machine Robotization, autonomous driving, dematerialization

9.3. Future and Future in the Present of Africa for Implementation of STEM Education and 4IR: For Casting

(Schwab, 2016) defines the Fourth Industrial Revolution's three main characteristics: systems impact, pace, and scope. The term "velocity" describes the rate of distribution and evolution of 4IR technology. The production of goods and services, especially in Africa, might become faster, more efficient, and more sustainable with the help of these technologies. Increasing national competitiveness (The Russian Federation declared that "AI is the future for humanity as a whole, not just for Russia." In today's economy, there are enormous opportunities as well as challenges that are hard to predict. The world will be ruled by whoever rises to the top in this domain. From an economic standpoint, Harvard University professor Michael E. Porter noted in the early 1990s that "a nation's competitiveness depends on the capacity of its industry to innovate and upgrade." This argument does a good job of demonstrating the strong correlation between national innovation capacity and competitiveness. As a cutting-edge technology, artificial intelligence (AI) has the potential to boost national competitiveness, increase productivity, and quicken the rate of innovation.

10. Conclusions

Since STEM education in 4IR represents a new paradigm in knowledge and technology, its effects will be felt by all people, everywhere whether developed country or under developed country. Even though they understand and want it, practically impoverished African nations find it difficult to create and implement strategies on their own due to their wide differences.

The majority of African nations, if not all of them, are still searching for answers to the economic, political, and educational issues that their citizens deal with. Digital technology has fundamentally changed and controlled the world's basic teaching and learning processes since the beginning of the fourth industrial revolution. The big question may raise here is, is there a measurement of being in 4IR? The answers to this is studying the principles of 4IR itself (Machaba and Bedada,2022). In the age of the fourth industrial revolution, STEM education has emerged as the primary factor advancing higher education across the globe. It is thought that by establishing a center of incubation, the quick

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development of technology in higher education has produced an effective teaching and learning environment in the twenty-first century. With this as the basis, the study's primary objectives were to identify the obstacles and potential trends facing African nations as they attempt to integrate STEM education and 4IR across the continent. Through an examination and assessment of the methodology and features of various materials and research articles, this study aims to present a strategy and technique for the implementation of 4IR in an African country. In order to answer the research questions that support the study's theoretical framework and help predict the steps that should be taken to implement STEM education and 4IR in Africa, the study used the archival research study process to examine the searched articles. This allowed the study to conceptualize and contextualize 4IR and STEM education. The results show that certain trends, such STEM power and experimento, were adopted across Africa. This, in my opinion, is the greatest trend that African nations may jointly adopt throughout the continent. In order to discuss the hot topics of the global 4IR, the African countries also arranged the PASET Forum (2019). In addition to these patterns, the report identifies the difficulties that African nations have encountered and will continue to confront on the continent. These difficulties include infrastructure, people skills, resources (budget), and, to some extent, job loss anxiety.

11. Recommendation

As STEM education is based on 4IR, it is better to bring the knowledge of 4IR to STEM education centers in Africa. The report suggests that in order to develop their economy and reduce the hazards associated with this cutting-edge technological revolution, African countries embrace contemporary technology especially in their education system.

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