Nexus Between Technology Innovation in Civil Engineering and Educational Sustainability in Nigeria

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Abstract: *Innovation is very imperative for the educational development of any nation. This article assessed the nexus between Technology Innovation in Civil Engineering and Educational Sustainability in Nigeria. The focus of this study was to examine the Education of Nigerian civil Engineers in Nigeria and investigated factors challenging technological innovation in Civil Engineering Education. It was discovered that the level of innovation and technology integration in Civil Engineering Education in Nigeria is low. Factors posing challenges to innovation in Nigeria includes institutional framework; human capital; research/innovation infrastructure; and sophisticated business community. This article recommended that the Government should evolve policies that would address the challenges in technological innovations Innovation. Government should provide adequate modern research facilities that would drive research in civil engineering at universities and in other tertiary institution in Nigeria. Modern research facilities should be established and human capital developed. The study concluded that if science and technology are well taught and adequate facilities are provided for the study of civil Engineering and other Engineering related study healthy and prosperous Nigeria is inevitable.*

Keywords: *civil; education; engineering; Nigeria; technology*

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INTRODUCTION

The impact of educational development on the natural environment has been a cause of increasing concern in recent years. An important outcome of these deliberations about the environment is sustainable development in Education as a result of innovation, which aims to reconcile economic growth and environmental protection. Engineering has been implicated in sustainability crises, including climate change, pollution and resource depletion. Sustainable engineering arose as a strategy to deliver positive engineering solutions and systems to benefit the environment, economy and society. Guiding it is a sustainability worldview which also necessitates sustainability education (Karlberg, & Bezzina, 2022). As the upshot of international declarations, sustainability education aims to induce in individuals the cognitive orientation needed for an increasingly complex and unpredictable world. The UN Decade of Education for Sustainable Development enhanced global efforts to mainstream sustainability education into various higher education institutions (Huckle, & Wals 2015). In 2004, the engineering education community issued the Barcelona Declaration, actively embracing sustainability education. The Declaration has since underpinned sustainable engineering education worldwide. Knowledge of sustainability is now a learning outcome of engineering programmes defined by various accreditation bodies including the Engineering Council, UK, the Accreditation Board for Engineering and Technology, USA and the Council for the Regulation of Engineering in Nigeria (COREN).

The classification of Africa as a third world, or an underdeveloped continent, despite its rich, human and material resources highlights the fact that there is a fundamental problem with the harnessing and utilization of the human and material resources in the continent (Gbadamosi, & Adisa, 2022). The Global Innovation Index (GII) 2014 surveyed 143 economies around the world, using 81 indicators to gauge both their innovation capabilities and measurable results. Mauritius, which tops the African countries in the ranking, came at the 40th position, followed by South Africa at 53rd and Tunisia at the 78th position Gbadamosi & Adisa, 2022). Nigeria was placed at the 110th position. The foregoing GII ranking has shown that in a global and dynamic world, the economies that can remain flexible, adaptive, and innovative will reap the benefits of world trade through educational sustainability . This is because the global competitiveness of any economy depends on its science, technology and innovation (STI) capabilities. In all ramifications of economic development, technology-dependent economies surpass economies dependent on their natural resources. However, there remain challenges to the diffusion of technology in Nigeria (Alhannom, & Mushabeb, 2021).

First, the law does not encourage technological innovation. Its capability to protect prospective innovators remains in doubt. Furthermore, Nigeria lacks human capital to man effectively its sectors. Moreover, research facilities in the country are either inadequate or outdated. There are no effective policies to serve as incentives to arouse local innovators and to attract foreign investors. Nigerian technological environment is discouraging. Modern infrastructures are also required to encourage foreign direct investment (FDI). Being a signatory to a number of sustainability-related treaties and resolutions such as Agenda 21, UNDEAD and UN 2030 Agenda for Sustainable Development, Nigeria has endorsed sustainability education. Since the colonial era however, Nigeria has engineered many infrastructures such as crude oil refineries, Ajaokuta steel plant, roads, railways, and many residential and office buildings. Nigerian Education have produced engineers who administer these projects. Nevertheless, Nigerian engineering education has not been assessed for its sustainability content. Hence this study assessed nexus between Technology innovation in Civil engineering and Civil Engineering education Sustainability in Nigeria. The study highlights Civil engineering practice in Nigeria, Technology Innovation in civil engineering before discussing the education of Nigerian engineers. Nigerian sustainability experience and efforts including sustainability education initiatives are considered (Akeel, 2018).

Education of Nigerian Civil Engineers

The origin of engineering education can be traced from two different distinct roots. First is the trade apprenticeship education where the trainees of the local trade program studied to advance their practical and theoretical knowledge of their various trades. The second root can be traced through the college or university that recognizes natural science which serves as a key point for specialization to an application in engineering (Steenwinckel, et al., 2021). (Durodolu, & Onaade, 2018) described engineering as ‘a three legged stool’ that relies on science, mathematics and techné. The author referred the word techné as the creative abilities that distinguish an engineer from scientist; to design, to make, to conceive and to actually bring to fruition. It is important to recognize that engineering is more than to simply understands the rudiments of science; it is basically a vocational subject which depends on the sound understanding of scientific principles as well as appropriate mathematics facility, the modeling language and vital communication. In an effort to keep America’s knowledge and technology driven economy, it categorizes engineering education as an

important national resource. The current technological innovations in the world came as a result of the trained personnel in the field of engineering and technology (Ramírez-Montoya, 2021).

The future of any nation does not only depend on its enormous natural resources possessed but the specialized engineering skills, competence and the ability of its populace to harness and utilize the resources. Engineering is the bedrock to economic, social and technological development of any nation because of its connection to all aspect of human activity (AlNuaimi, et al., 2021). The quality of engineering graduates from universities and polytechnics in Nigeria has been the major concern by the industries over the years. The industries mostly complaint of inadequate skills required especially in the current cutting-edge technology, having low practical know-how and lack of confidence. Going by the quality of training acquired by the graduates of tertiary institutions in Nigeria in the area of engineering education, most of them are engaged into several re-training by the industries in order to build their skills for the fact that they are considered to be unemployed at the first intake level (Laleye, 2022)

The technological and industrial development of any nation depends on its ability to develop its citizens towards human resources especially in the area of science and engineering. Due to poor infrastructural facilities haunting Nigerian tertiary institutions, coupled with the number of graduates from different institutions of higher learning that failed to transform the economic fortune of the country towards industrialization, the nation is far from experiencing technological advancements and economic growth (Uchenu, et al., 2019) attributed the obstacle to national development and growth to lack of viable engineering education and training. The condition in Nigeria can be described as poor due to inability of our leaders to make provisions that are necessary for national development since after the independence, according to Meka, (2022)., valuable changes that could bring positive changes in terms of improving the living standards of the citizens, brings about employment opportunity, poverty reduction and many other things are the quest for national development.

Civil engineering practice in Nigeria

Engineering is a general term used to describe the ability to think and utilize the sciences-based theories in solving one problem or the other for the purpose of improving the living standard of the creatures. Engineering discipline is of various branches and meant for different purposes, for example “Civil Engineering” is that branch of Engineering that deals with the design, constructions and maintenance of infrastructural facilities for the betterment of all (Álvarez et al., 2021). These infrastructures may include Building structures, hydraulic structures, Highways, Dams, Tunnels, Railways, Towers and Bridges etc. Civil engineering is a big profession that involves a range of different sub-disciplines or specializations. These include; construction engineering, structural engineering, water resources engineering, geotechnical engineering, transportation engineering, municipal or urban engineering, environmental engineering, materials engineering, coastal engineering, architectural engineering and surveying. Civil engineers don’t only have that social responsibility to properly maintain and adapt structures that we depend on in our daily life, they are also involve in making sure the infrastructures are adapted to meet natural disaster, population growth and climate change challenges. They have that responsibility to find and implement solutions to complex problems. However, these engineers faces many challenges in executing their duties or carrying on their responsibilities effectively. Due to the pivotal role civil engineering plays in the development and improvement of societies, (Foster et al., 2022) described its

endeavors as complex and diverse undertakings that tackle nonstandard challenges. One of the major challenges faced in civil engineering in the developing countries is that of sustainability in construction (Alshboul, et al., 2022). Ziervogel, (2022) stated that enough attention has not been given to sustainable construction in Africa. Stanitsas, and Kirytopoulos, (2021), affirmed that the use of the term sustainable construction was to describe the role of the construction industry in the attainment of sustainability.

(Ding, 2008) asserted that the perspective of developing countries were not captured when certain framework for sustainable construction were designed and therefore, the framework might not be appropriate to apply to the case of the developing nations. The direct application of experience gathered from the developed world to the developing nations like the African countries has not worked out as the priorities and national circumstances of the African nations are not the same with those of the developed countries. Therefore, the definition of sustainable development and construction within the African context need to be redefined as advised by (Haniff, & Galloway 2022). (Wang et al, 2021), affirmed that the concept of sustainable development is still an evolving one that depends on how its implementation is carried out on the development at both regional and local approaches and solutions. Due to the difference in definition, approaches and solutions between the developed and developing nations, there is need for the creation of an international agenda for sustainable building that recognises these local and regional differences (ibid). Hallin et al., (2021) argued that there must be a proper understanding of the social, political and economic atmosphere and the developmental issues of a particular place before talking about sustainable construction in the that area. The author further advocates that when all the issues raised are better understood, sustainable construction then becomes are integral part of sustainable development. Adebayo cited the wars, conflicts and pandemic diseases as examples of practical issues that have put the issue of sustainable construction into debate when it is brought to the table for discussion and makes the issue of sustainable construction in Africa to be seen differently from the way it is seen in the developed world. As part of the recognition of the local and regional differences, Díaz-López, et.al., (2022) advice that there is need to organize a number of regional sustainable building conferences with the development of regional sustainable action plans for sustainable building and sustainable construction in Africa being at the fore. The author further reiterated that "The key issue is the establishment of a solid knowledge foundation for Africa that will equip the public, professionals, development agencies and governments with accurate and relevant knowledge generated within the framework of the continent's social needs, its cultures and its biophysical environment to guide their decisions and actions towards establishing a sustainable built environment."

Technology Innovation in civil engineering

The technological innovation of civil engineering construction is involved with the benefit achievements and the brand creation of engineering construction companies, and also closely related with the improvement of people's living conditions (Hu, 2016). As civil engineering is the principal part of engineering construction, the construction parties of civil engineering must make technological innovation based on the changing and developing society, and use new technologies and new methods to make construction of projects. The section of this study makes analysis on several means of technological innovation of civil engineering construction, purposed to promote the practical development of civil engineering through helpful discussion and exploration. Traditionally, the construction

industry is known to have passive reaction for emerging technology (Qin, 2022).

In recent years, the technology available to increase productivity has seen rapid adoption and advancement. The recent development in the computational tools and hardware has correspondingly enhanced the construction methodology also to keep pace with the developments in design developments. For example, the development in concrete technology has led to the use of automated batching plants, temperature-controlled transit mixers and placer booms. In an identical manner, Project management, Estimation and Building Information Modelling technologies are now commonly found in construction. The need for efficiency in managing the construction process and emerging technologies is the result of best opportunities to improve the construction process through better integration and efficiency (Laato, 2022).

The growth of new technologies in the construction industry is expected to have impact on the way construction is performed in future. With any new methodologies, there are expected to be changes in the composition of workforce. In the recent past emerging technology in the construction industry has focused on communication and collaboration, as the benefits to the construction process by improvement in these areas is obvious. Two types of technology have dominated in these areas, building information modeling (BIM), which has established a solid reputation for collaboration and cloud computing, which has emerged more recently as a solution for collaboration (García de Soto et al., 2022)

Building Information modeling (BIM) tool provides extensive information about the nature & magnitude of work, documentation, specification, design, planning and scheduling construction resources, workmanship, quality, safety, energy analysis, life cycle costing (McNeil-Ayuk, & Jrade, 2023). In the past, few decades, there have been growing interests of the construction sector using BIM due to many benefits & effective utilization of resources during design, planning & construction of new buildings. The BIM is mainly focused on developing different models by adding time, cost and energy analysis in existing 3D model. It has potential to increase efficiency of the project, minimize waste and increase sustainability across construction projects. Although, studies in the past reported the application of BIM mostly in building construction; however, limited studies have been reported in infrastructure (Wong&Fan, 2013).

Technology has considerable influence in the field of civil engineering and plays important role in the management of construction Industries (Ogunnusi, et al., 2022). From the planning to the implementation and controlling, technology innovation helps on every stage of the construction and its management, by enhancing the Work-ability with the advancement in the methodology. Many researchers have presented new ideas for supporting the construction management using IT. With every new construction technology, the working process enhances and gives new methodology of construction. The main use of information technology is to automate and integrate the functions of construction project aiming increased productivity. Technology innovation has decisive impact on every stage of construction management such as planning, scheduling, implementation, controlling and monitoring. It also helps the decision maker to avoid/overcome the delays and wastage of the time, material and assets by providing real-time data.

Building Information Model is primarily a three-dimensional digital representation of a building and its intrinsic characteristics. It is made of intelligent building components which includes data attributes and parametric rules for each object. BIM provides consistent and coordinated views and representations of the digital model including reliable data for each

view. This saves a lot of designer's time since each view is coordinated through the built-in intelligence of the model. Building Information Modelling is the process and practice of virtual design and construction throughout its lifecycle. It is a platform to share knowledge and communicate between project participants. CAD is no longer just about drafting. Autodesk BIM solutions allows to explore and evaluate a project's constructability before it's built, improve cost reliability, visualize construction processes through 4D simulation and clash detection, increase coordination between stakeholders throughout the design and construction process, and better predict, manage and communicate project outcomes.

Civil Engineering education Sustainability in Nigeria

The Nigerian tertiary institutions are faced with enormous challenges in terms of general conduct of engineering education programs which failed to equip students with the necessary skills to cope with the challenges of world of work and the modern day society. Also, the world itself currently faces energy, environmental and economic crisis as a result of unhealthy human practices on natural resources and the environment, the demand for more efficient buildings, homes, transportation, consumer products and alternative renewable energy that will positively affect the society has remained the yearnings of many nations. Having seen this, the United Nation (UN) constituted 2005-2014 as the Decade for Education for Sustainable Development (DESD). The Agenda 21 of the UNDESD emphasizes the link that must be constructed between academia as well as the needs of the community. and also to enact sustainability in higher education in order to positively affect the society as well as biosphere (Sanusi, & Khelghat‐Doost, 2008).

Four main objectives were identified by UNESCO that will do this plan of which the second speaks straight to education, which is "Rethinking as well as Revisiting education from nursery school to university to include a clear aim of future and current societies on the development of knowledge, skills, attitudes and values in connection with sustainability". This implies that; the objectives and contents of existing curricula from Nursery education to University education should be reviewed and developed to integrate the interdisciplinary understanding of social, economic and environmental sustainability; and also to recommend and make mandatory the methods of teaching, learning and assessment of sustainability programmes.

In other to achieve this great feat, education and higher education in particular was earmarked by united nations as the most convenient and appropriate avenue for advancing this training and creation of awareness about sustainability. Engineering Education is being taught in Nigeria at University level as well as Polytechnics level. The National Universities Commission (NUC) is actually the government umbrella group which oversees the administration of Higher Education in Nigeria. NUC being the administrative body of universities listed 152 universities as accredited degree granting institution in the site of its report as at 2017 (Sanyang, 2021). In addition to Universities, National Board for Technical Education (NBTE), the federal government body which oversees Polytechnics in Nigeria, recognized 107 polytechnics in Nigeria as at 2017.

Engineering Education in Nigeria, is actually acquired over a period of 5 years in universities and 2 years in Polytechnics (Tugwell, & CN, 2022). In the first and second year of studies, engineering education learners are usually taught Chemical and Physical Science subjects that is ordinarily accompanied by one or perhaps two Social Science subjects like use of English. Learners are progressively subjected to the core of the chosen disciplines of theirs within the three years and inside the 3years research of core engineering, students

are actually required to go through a mandatory Industrial Work Experience Scheme serving as an avenue to come across the actual world of work of the engineering programme. Engineering students then undertake a research project either collectively or individually under the supervision of an academic in the last session of the programme of theirs. A Bachelor of Engineering is actually given to the engineering graduates upon effective completion of the programme. Various research findings have revealed that, lack of adoption and implementation of sustainability policies, strategies and programmes in the industries and educational curriculum are the major factors responsible for poor infrastructural development, ecological and economic challenges looming in Nigeria today (Warfvinge et a., 2022).

Having being recognized as the lifeblood of socioeconomic progress in any nation, engineering is seen as the solution to the challenges of sustainability. Engineering community all over the world have invented sustainable engineering as a concept that will help them leave the conventional Engineering practice. However, Oyewobi, et al (2022) stated that, the question regarding the extent to which the sustainability worldview has been embraced by the Nigerian Engineering community remains unanswered. This study is actually an effort to respond to the question about the knowledge of sustainability among the members of the Nigerian Engineering community and how can sustainability education be incorporated into Engineering Education Programme in Nigeria.

CONCLUSION

Technology-dependent Education surpass theoretical dependent on their natural resources. Therefore, the education that can remain flexible, adaptive, and innovative will reap the benefits of technology. This is because the global competitiveness of any Education depends on its science, technology and innovation capabilities. Based on various literature reviewed in this study which revealed that Nigeria is currently lagging behind technologically, hence if science and technology are well taught and adequate facilities are provided for the study of civil Engineering and other Engineering related study healthy and prosperous Nigeria is inevitable.

SUGGESTIONS

This study recommended that; Government should evolve policies that would address the challenges in technological innovations Innovation. Government should provide adequate modern research facilities that would drive research in civil engineering at universities and in other tertiary institution in Nigeria.Modern research facilities should be established and human capital developed

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