



Innovations and Skills Needed For Sustainable Knowledge Development in the Fifth (5th) Industrial Revolution in Public Universities in Rivers State.

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Abstract

The study investigated the innovations and skills needed for sustainable knowledge development in the fifth industrial revolution in public universities in Rivers State. Using descriptive survey design, two research questions and two hypotheses guided the study with a population of 4,840 lecturers in the three public universities in Rivers State. A sample of 484 lecturers representing 10% of the population was drawn through the stratified random sampling technique. The researcher developed questionnaire tagged, “Innovations and Skills Needed for Sustainable Knowledge Development in the Fifth Industrial Revolution in Public Universities in Rivers State Questionnaire (ISNSKD5IRPURSQ)” was used for data collection. The instrument which had 18 items was properly validated and the reliability test through Cronbach Alpha method yielded 0.86. Mean scores, standard deviation and mean set scores were used to analyse the research questions, while z-test at 0.05 level of significance was used to test the hypotheses. Results of the study revealed among others that, the innovations needed for sustainable knowledge development in the 5IR in public universities in Rivers State include: introduction of artificial intelligence, internet of things, collaboration/interdisciplinary research, and bridging the digital divide. The skills needed for sustainable knowledge development as revealed by the study among others include: digital literacy skills, data analytical skills, creative and critical thinking skills. Based on these findings, conclusion was drawn and the following recommendations among others were made: public universities in Rivers State should carefully introduce relevant innovations required for sustainable knowledge development in the 5IR in their institutions; and universities should lay emphasis on the inculcation of skills needed for sustainable knowledge development in the 5IR.

Keywords: Innovations, Skills, Sustainable Knowledge Development, Public Universities, and Fifth Industrial Revolution (5IR)

Introduction

Knowledge development and dissemination are part of the major roles of universities worldwide. They do this through their engagements in research, because it has been identified that human advancement to a better standard of living relies so much on knowledge and information. The world has gradually transitioned to the fifth industrial revolution which is characterized by the convergence of physical, digital, and biological systems. This revolution will bring a lot of changes in the industries, economies and societies, with far-reaching



implications for education, innovation and sustainable development. Sustainable knowledge development in the fifth industrial evolution (5IR) signifies the creation, dissemination and application of knowledge that balances economic, social and environmental sustainability.

Public universities in Rivers State are universities built and funded by either the state or federal governments. There are three public universities in Rivers State that have been responding to the sustainable development challenges within the region (Ofor-Douglas, 2023). However, the emergence of the 5IR has presented both opportunities and challenges to these universities. According to Xu, David, and Kim (2018), they are required to adapt to technological changes taking place in the education sector and review their curriculum to enable their staff and students take advantage of this revolution and remain relevant. The 5IR as defined by Nahavandi (2019) is a concept that builds upon the fourth industrial revolution by emphasizing on a more human-centric and sustainable approach to manufacturing and production. It focuses on integrating humans with advanced technology and AI-powered robots to enhance processes, create more sustainable products, and foster a resilient workforce.

Boer and During (2001) defined innovations as the introduction of new or improved ideas, products, services, processes, or methods that create value and drive progress. Innovations are of different types, such as product, process, service or business model innovations (Yeboah, 2023). Lamri and Lubart (2023) defined skills as the abilities, knowledge and competences that individuals possess to perform specific tasks, solve problems or achieve set goals. Skills can be technical, soft or cognitive skills. Embracing modern innovations and skills and applying them efficiently and effectively in service delivery by public universities in Rivers State can position them as hubs for sustainable knowledge development for the enhancement of economic growth, social progress and environmental sustainability in the south - south geopolitical region (Ofor-Douglas, 2023).

Statement of The Problem

The fifth industrial revolution (5IR) has come with a lot of changes: It is transforming the world with new ways of doing things. It is bringing a lot of unprecedented opportunities and challenges to various institutions all over the world. Public universities in Rivers State, like many other higher education institutions, are facing the overwhelming task of adapting to this new era. Despite the growing awareness of the importance of innovations and skills development in the 5IR, there is limited empirical research evidence on the specific innovations



and skills needed for sustainable knowledge development in public universities in Rivers State. The researcher identified this knowledge gap; hence, this study aims at filling this gap.

Aim and Objectives

This study aimed at investigating the innovations and skills needed for sustainable knowledge development in the 5IR in public universities in Rivers State. Specifically, the objectives of the study are to:

1. Identify the innovations that are needed for male or female lecturers for sustainable knowledge development in the 5IR in public universities in Rivers State.
2. Examine the skills that are required for male or female lecturers for sustainable knowledge development in the 5IR in public universities in Rivers State.

Research Questions

This study will provide answers to the following research questions:

1. What are the innovations that are needed for male or female lecturers for sustainable knowledge development in the 5IR in public universities in Rivers State?
2. What are the skills that are required for male or female lecturers for sustainable knowledge development in the 5IR in public universities in Rivers State?

Research Hypotheses

The following research hypotheses were tested at 0.05 level of significance:

- HO₁: There is no significant difference between the mean responses of male and female lecturers on the innovations that are needed for sustainable knowledge development in the 5IR in public universities in Rivers State.
- HO₂: There is no significant difference between the mean responses of male and female lecturers on the skills that are required for sustainable knowledge development in the 5IR in public universities in Rivers State.

Literature Review

Theoretical Literature Review

This study was anchored on the knowledge management theory and the human capital theory. The knowledge management theory was propounded by Nonaka and Takeuchi (1995). The theory explains how organizations grow and manage knowledge through four processes: socialization, externalization, combination and internalization (SECI). Their theory emphasizes the importance of knowledge creation, sharing, and utilization in organizations, highlighting the interplay between tacit and explicit knowledge. This theory is very relevant to



this study because it can help us understand how public universities can manage knowledge effectively in the fifth industrial revolution.

The human capital theory explains the importance of investing in human capital through education and skills development. The concept of human capital was pioneered by classical economists like Adam Smith, but the scholarly works of Gary Becker and Theodore Schultz, Becker (1964) and Schultz (1961) respectively, formally developed and popularized the theory. The human capital theory emphasizes the role of education and training in enhancing productivity, economic growth and individual prosperity. This theory is relevant to this study because it will help us understand the role of public universities in training and equipping individuals with skills and knowledge that will help them to be relevant in the fifth industrial revolution.

Conceptual Literature Review

Concept of Sustainable Knowledge Development

Sustainable knowledge development, according to Rieckmann (2018), focuses on creating and disseminating knowledge that supports long-term human well-being and environmental health without compromising the needs of future generations. This involves acquiring the knowledge, skills, values and attitudes necessary to address issues like climate change, resource depletion, and inequality. It also emphasizes learning that improves cognitive abilities, building socio-emotional skills and encouraging positive actions for a sustainable future. The key aspects of sustainable knowledge development according to Rieckmann (2018) include the following: education for sustainable development (ESD), interdisciplinary approach, local knowledge, lifelong learning and empowerment. In essence, sustainable knowledge development is about empowering individuals to become active participants in creating a more sustainable and equitable world. The benefits of sustainable knowledge development, according to UNESCO (2017), are increased awareness and understanding; empowerment for action; improved quality of life; long-term benefits.

To foster sustainable knowledge development in public universities within Rivers State in the era of fifth industrial revolution, innovative approaches are needed. It would appear necessary to integrate cutting-edge technologies such as artificial intelligence (AI), big data, and internet of things (IOT). Emphasis should be placed on developing and supporting human- machine collaboration through educational programs and ensuring ethical and inclusive use of technology (Breque et al., 2021). This includes equipping faculty and students with the



necessary skills to utilize these technologies, fostering collaborative research, and ensuring equitable access to resources.

Public universities in Rivers State would need to leverage on advanced technologies such as: Artificial intelligence and machine learning: They need to adopt artificial intelligence for personalized learning experiences, data analysis, and predictive modelling in various fields. The adoption of AI will enhance students learning outcomes and effective administration (Gürdür Broo et al., 2022). The use of internet of things will improve personalized learning experiences, adaptive teaching methods, and data-driven decision-making. Adopting machine learning will promote adaptive assessments and intelligent tutoring systems, Big data analytics according to Adigun et al. (2024), Garzon (2021) and Akçayır et al. (2016) can promote sustainable knowledge development in public universities by raising their capacity for data-driven decision-making, personalized learning and optimized resource allocation. Leveraging big data analytics by universities can improve student outcomes, enhance research and innovation, and driven sustainable knowledge development (Labhane et al., 2024).

Also, the use of virtual reality (VR) and augmented reality (AR) can significantly promote sustainable knowledge development in the fifth industrial revolution in public universities by providing immersive learning experiences, increasing accessibility, and enhancing collaboration. The integration of 3D printing and robotics in university education in the fifth industrial revolution, according to Singh et al. (2024), increases sustainable knowledge development by providing hands- on learning experiences, promoting interdisciplinary collaboration, and driving innovation and entrepreneurship. Integrating and leveraging advanced technologies will help universities to develop and train skilled graduates, drive economic growth, and address sustainable development challenges.

Studies have also shown that promoting interdisciplinary research will be necessary in promoting sustainable knowledge development in the 5IR. This could be carried out through cross faculty collaboration, industry-academic partnership, and establishment of research centres and research incubators. Cross-faulty collaboration involves academics from different departments or faculties coming together or partnering to carry out a study within the university. Industry- academic partnership indicates the existence of partnership or collaboration between universities and industries to promote innovations, knowledge development and transfer. Public universities can promote interdisciplinary research by building well established research centres and incubators to enhance interdisciplinary research.



According to Wang and Barabasi (2021) interdisciplinary research has increased creativity and innovations in the institutions where they are practiced. It has equally promoted the capacity of such institutions in finding solutions to complex problems. Its contribution to knowledge development cannot be underestimated. It can result to novel ideas and knowledge, as well as an in-depth comprehension of complicated problems.

The fifth industrial revolution, according to Aslam et al. (2020), lays more emphasis on human-machine collaboration, promotes greater integration between humans and machines, the 4IR innovation calls for regular data interchange over networks between production equipment and industrial information systems, presenting significant challenges in developing diverse industrial network protocols. With the emergence of breakthrough technologies, the industry is currently undergoing a transformative shift from the integration of digital technology with the material system (4IR) to a paradigm where human involvement plays a crucial role in both the digital and material systems (5IR). This is because human intelligence is essential to enhance the productivity of machine automation coupled with digital technology.

Ethical considerations are crucial in the fifth industrial revolution. This focuses on human machine collaboration and sustainability. The 5IR prioritizes the needs and well-being of humans, ensuring that technology enhances rather than diminishes human capabilities. Human-centered design aims to make systems usable and useful by focusing on the users, their needs and requirements and by applying human factors/ergonomics, and usability knowledge and techniques.

According to Mattila et al. (2022) the goals of the 5IR is to strike a balance between machine and human engagement, establish collaboration between people and robots, combine cognitive computers and human intelligence, personalization and customization of products to the needs of people, and enhancing environmental sustainability through renewable energy sources. The 5IR also emphasizes ethical AI implementation, which addresses concerns like fairness, privacy, and security in AI- driven systems. It also prioritizes bridging the digital divide, ensuring all communities have access to technology and opportunities. Fostering a human-centered approach involves prioritizing the needs, experiences and perspectives of individuals in all aspects of a system or design. It is about understanding people, their challenges, and their aspirations to create solutions that truly meet their needs. Fostering a human-centered approach will involve empathy, collaboration, user-centered design, focus on well-being, flexibility and adaptability.



Sustainable knowledge development in the 5IR will require a lot of skills. There is a need for a blend of technical and soft skills. According to Adigun et al. (2024) some of the skills required include: digital literacy and data analysis skills, problem-solving and critical thinking skills, adaptability and lifelong learning, ethical considerations, communication and collaborative skills etc. Grabowska and Saniuk (2023) identified entrepreneurial skills, technical and managerial skills, openness to digitalization, creative skills, analytical skills, decision-making skills, and lifelong learning skills as vital skills relevant in sustainable knowledge development in the 5IR. To prepare for the transformative future, people must equip themselves with essential skills that will empower them to thrive amidst automation and innovation. According to Poláková et al. (2023), the top skills indispensable in the fifth industrial revolution include creativity, critical thinking and problem-solving, adaptability, digital literacy, emotional intelligence, resilience, and cross-cultural competence.

These skills will enable people to go through the complexities of the fifth industrial revolution and contribute their quota to sustainable knowledge development. Specifically, creative thinking skills will promote the generation of innovative ideas, solutions, products and services that address complex challenges and provide new opportunities; critical thinking skills will enhance the ability of people to analyze complex information, evaluate evidence and make informed decisions; problem-solving skills will enable individuals to handle complicated tasks, interdisciplinary problems and proffer effective and sustainable solutions. Digital literacy skills enhances the capacity of individuals to navigate, evaluate and utilize digital technologies to access, create and share knowledge; adaptability skills helps people to cope with changing technologies and societal needs; resilience skills promote people's ability to work hard, cope with uncertainties and tough situation and the emotional intelligence skills enhance empathy, self-awareness, social and communication skills, as well as other skills that promote collaboration and diversity management in the fifth industrial revolution.

Methodology

The researcher made use of a descriptive survey research design. The population of the study was all the 4, 840 lecturers in the three public universities in Rivers State. Source: Academic Planning Units of these Universities (2024 Report). A sample size of 484(260 male and 224 female) lecturers representing 10% of the population was drawn through stratified random sampling technique. A self-structured questionnaire instrument entitled, "Innovations and Skills Needed for Sustainable Knowledge Development in the Fifth Industrial Revolution in



Public Universities in Rivers State Questionnaire (ISNSKD5IRPURSQ)” was used for data collection. The instrument, which had 18 items, was properly validated; reliability was established using the Cronbach's alpha method, yielding a coefficient of $\alpha = 0.86$. Mean scores, standard deviation and mean set were used to answer the research questions, while z-test at a 0.05 level of significance was used to test the hypotheses.

Results

Research Question One: What are the innovations that are needed for sustainable knowledge development in the 5IR in public universities in Rivers State?

Table 1: Mean responses, standard deviation and mean set analysis of the data obtained from the male and female lecturers on the innovations that are needed for sustainable knowledge development in the 5IR in public universities in Rivers State.

S/N	Innovations needed for sustainable knowledge development in the 5IR.	Male Lect. N = 260		Female Lect. N = 224		Mean set	Remarks
		\bar{X}_1	SD ₁	\bar{X}_2	SD ₂		
1	Integration of Artificial intelligence in administration and educational programs in public universities	3.14	0.58	3.16	0.56	3.15	Agree
2	Adoption of Internet of Things (IOT) for academic and administrative activities	3.10	0.60	3.10	0.59	3.10	Agree
3	Introduction of 3D printing and robotics in university education	3.02	0.66	3.00	0.67	3.01	Agree
4	Promotion of interdisciplinary research	3.12	0.59	3.08	0.61	3.10	Agree
5.	Collaboration between individuals and robotics through educational programs	3.08	0.61	3.06	0.62	3.07	Agree
6.	Bridging the digital divide	3.06	0.63	3.04	0.63	3.05	Agree
7.	Adoption of virtual reality/augmented reality.	2.99	0.68	2.96	0.68	2.98	Agree
8.	Fostering a human-centered approach or well-being through educational programs	3.04	0.65	3.02	0.65	3.03	Agree
9.	Adopting technologies without user-centered design	2.28	0.70	2.24	0.74	2.26	Disagree
Aggregate mean and standard deviation		2.98	0.63	2.96	0.64		

Criterion mean = 2.50

Table 1 shows that items 1 to 8 had weighted mean scores that are greater than the criterion mean of 2.50. They were agreed upon by the respondents as the innovations that are needed for sustainable knowledge development in the 5IR in public universities in Rivers State. The aggregate weighted mean scores of 2.98 and 2.96 for male and female lecturers respectively



which are far above the criterion mean show that the respondents shared similar opinion on the innovations needed for sustainable knowledge development in the 5IR in public universities in Rivers State.

Therefore, the innovations needed for sustainable knowledge development in the 5IR in public universities in Rivers State include: integration of artificial intelligence, internet of things, 3D printing and robotics, virtual reality and augmented reality for administrative and academic programs in the university. Others are promotion of collaborative/interdisciplinary research, bridging the digital divide, promotion of collaboration between individuals and robotics, and fostering human-centered approach or well-being through educational programs.

Research Question Two: What are the skills that are required for sustainable knowledge development in the 5IR in public universities in Rivers State?

Table 2: Mean responses, standard deviation and mean set analysis of data obtained from the male and female academics on the skills that are required for sustainable knowledge development in the 5IR in public universities in Rivers State.

S/N	Skills required for sustainable knowledge development in the 5IR in public universities in Rivers State	Male Lect. N = 260		Female Lect. N = 224		Mean set	Remarks
		\bar{X}_1	SD ₁	\bar{X}_2	SD ₂		
1	Digital literacy skills	3.46	0.60	3.42	0.63	3.44	Agree
2	Data analytical skills	3.40	0.62	3.38	0.64	3.39	Agree
3	Critical thinking skills	3.48	0.59	3.44	0.61	3.46	Agree
4	Creative skills	3.52	0.57	3.50	0.58	3.51	Agree
5.	Problem-solving skills	3.54	0.56	3.56	0.56	3.55	Agree
6.	Communication/collaborative skills	3.32	0.65	3.34	0.66	3.33	Agree
7.	Routine manual labour skills	2.32	0.69	2.24	0.72	2.28	Disagree
8.	Adaptability/lifelong learning skills	3.38	0.63	3.26	0.68	3.32	Agree
9.	Emotional intelligence skills	3.28	0.67	3.30	0.67	3.29	agree
Aggregate mean and standard deviation		3.30	0.62	3.27	0.64		

Criterion mean = 2.50

Table 2 shows that all the items had weighted mean scores that were greater than the criterion mean, except item number 7. All the items were accepted by the respondent as the skills required for sustainable knowledge development in the 5IR in public universities in Rivers State, except item number 7. The aggregate mean of 3.30 and 3.27 for male and female lecturers, respectively are very close. This indicates that the respondents shared the same view



on the skills needed for sustainable knowledge development in the 5IR in public universities in Rivers State.

Therefore, the skills required for sustainable knowledge development in the 5IR in public universities in Rivers State include: digital literacy skills, data analytical skills, critical thinking skills, creative skills, problem-solving skills, communication/collaborative skills, adaptability/lifelong learning skills, and emotional intelligence skills.

Test of Hypotheses

The following hypotheses were tested at the 0.05 level of significance.

Hypothesis One: There is no significant difference between the mean responses of male and female lecturers on the innovations that are needed for sustainable knowledge development in the 5IR in public universities in Rivers State.

Table 3: z-test of difference between the mean responses of male and female lecturers on the innovations needed for sustainable knowledge development in the 5IR in public universities in Rivers State.

Gender	N	\bar{X}	SD	DF	Z-Cal	Z-Crit	Level Of Sign	Decision
Male Lecturers	260	2.98	0.63	482	0.345	± 1.960	0.05	Null hypothesis Not significant
Female Lecturers	224	2.96	0.64					

Table 3 shows a summary of mean, standard deviation and z-test of the difference between the male and female lecturers on the innovations needed for sustainable knowledge development in the 5IR in public universities in Rivers State. The z-test calculated which was used in testing the hypothesis stood at 0.345 while the z-critical value was ± 1.960 at 482 degree of freedom using 0.05 level of significance. The z-calculated was by far less than the z-critical value. This implies that, there was no significant difference between the mean scores of the male and female respondents on the innovations needed for sustainable knowledge development in the 5IR in public universities in Rivers State. Hence, the null hypothesis was retained.

Hypothesis Two: There is no significant difference between the mean responses of male and female lecturers on the skills needed for sustainable knowledge development in the 5IR in public universities in Rivers State.



Table 4: z-test of difference between the mean responses of male and female academics on the skills needed for sustainable knowledge development in the 5IR in public universities in Rivers State.

Gender	N	\bar{X}	SD	DF	Z-Cal	Z-Crit	Level Of Sign	Decision
Male Lecturers	260	3.30	0.62	482	0.522	± 1.960	0.05	Null hypothesis Not significant
Female Lecturers	224	3.27	0.64					

Table 4 shows a summary of mean standard deviation and z-test of difference between the male and female lecturers on the skills needed for sustainable knowledge development in the 5IR in public universities in Rivers State. The z-test calculated, which was used in testing the hypotheses, stood at 0.522 while the z-critical value was ± 1.960 at 482 degrees of freedom using 0.05 level of significance. The z-calculated was by far less than the z-critical value. Therefore, the null hypothesis of no significant difference between the mean responses of male and female lecturers on the skills needed for sustainable knowledge development in the 5IR in public universities in Rivers State was retained.

Discussion

The findings of the study revealed that the innovations needed for sustainable knowledge development in the 5IR in public universities in Rivers State include integration of artificial intelligence, internet of things (IOT), 3D printing and robotics, virtual reality/augmented reality, and promotion of collaborative research. These findings are supported by Gürdür Broo et al. (2022), Adigun et al. (2024), Garzón (2021), Akçayır et al. (2016), Labhane et al. (2024), and Singh et al. (2024). The introduction of these technological innovations in the university system will promote students' learning outcomes and effective administration of public universities in Rivers State. It will enhance personalized learning experiences, adaptive teaching methods, and data-based decision-making processes.

The adoption of these technological innovations in the university system is necessary because it will increase access to university education, promote adaptive assessment of students, provide hands-on- learning experiences, and improve inter- and intra-disciplinary collaborations among academics and students. The findings of this study further revealed that bridging the digital divide; promotion of collaboration between human beings and robots; and fostering of human-centered approach/well-being through educational programs are part of the



innovations needed in the 5IR for sustainable knowledge development in public universities in Rivers State. These findings are supported by Wang and Barabasi (2021), Aslam et al. (2020), and Mattila et al. (2022). There is a need to ensure equal opportunities for individuals. Bridging the digital divide will promote equitable access to resources.

Promoting collaboration is very necessary in the 5IR. Collaborative research within a faculty and between faculties could result in the development of new knowledge and skills, as well as groundbreaking research outputs that could offer solutions to our problems. Collaborative research could also take place between universities and industries, among universities and faculties. A major innovation in the 5IR is the emphasis on human-machine collaboration. This is because it has been observed that humans have crucial roles to play in both digital and material systems. Human intelligence is required in managing and enhancing the productivity of digitally automated machines. This is part of the reason for the desire to strike a balance between machine and human engagement. Hence, the attempt to foster a human-centered approach in the 5IR will involve prioritizing the needs, experiences and perspectives of human beings in all aspects of system design.

The study revealed that the skills essential for sustainable knowledge development in the 5IR in public universities in Rivers State include digital literacy skill, data analytical skill, critical thinking skill, creativity skill, problem-solving skill, communication/collaborative skill, adaptability/life-long learning skill, and emotional intelligence skills. Adigun et al. (2024) and Grabowska and Saniuk (2023) support these findings. These skills are necessary for one's survival in the 5IR. Digital literacy is so essential that without it, one will be in darkness and will find it difficult to make any meaningful progress. The adoption and effective implementation of AI technologies are based on the assumption that staff and students are not digital aliens. But the truth is that so many staff members and students in public universities are digital aliens. Some of them have not used a computer in their life, especially those coming from remote areas. It will be difficult for these sets of people to leverage opportunities provided by advanced technologies of the 5IR to access, utilize and share knowledge.

Creative skills are essential for knowledge development because it will help individuals to come up with new ideas, solutions, products and services that serve as answers to societal problems. Creative skills will equally help individuals to create new opportunities. Critical thinking skills are very important in decision-making processes. It helps individuals to compare information at their disposal in order to make informed decisions. Creative skills and critical



thinking skills enhance problem solving. They promote the development of problem-solving skills which enhance the capacity of individuals to handle great challenges effectively with adequate considerations to human, technological and environmental factors. Communication and collaborative skills are also essential for sustainable knowledge development in the 5IR. This is because this era lays so much emphasis on collaborations at various levels: inter-faculty, interdisciplinary, university-industry, etc. Collaborations at any level could only be possible with cordial relationships and effective communication existing among the partners.

Other skills required include adaptability skills, emotional and data analytical skills. We live in a changing world. Individual needs, societal needs and technological needs are changing by the day. Adaptability skills will enable people to cope, tolerate and remain relevant in such circumstances. Emotional intelligent skills are those skills that allow individuals to cordially relate with one another such as empathy, self-awareness, tolerance, equity or fairness etc. These skills enable individuals to communicate, collaborate and achieve results in the mist of various complexities and diversities. Data analytical skills have to do with the ability of an individual to collect, organize, and analyze data to make informed interpretations and decisions. It helps individuals to identify trends, opportunities and challenges. Data analytical skills require a good knowledge of some statistical tools like SPSS, python and Tableau. Data analytical skills are aided by digital literacy skills. These skills are vital for survival and sustainable knowledge development in the 5IR, hence public universities in Rivers state should ensure that they inculcate these skills into their students.

Conclusion

This study investigated innovations and skills needed for sustainable knowledge development in the 5IR in public universities in Rivers State. Based on the findings, it was concluded that these innovations and skills are essential for sustainable knowledge development and the production of university graduates who will leverage on modern technology to take advantage of opportunities offered by the 5IR and contribute their own quota in the development of the state. Integrating these innovations and skills in public universities in Rivers State will enhance students learning outcomes, administrative efficiency and the relevance of public universities in Rivers State in the era of 5IR.



Recommendations


Based on the findings, the following recommendations were made:

1. Management of public universities in Rivers State should integrate artificial intelligence into their educational system for sustainable knowledge development in the 5IR.
2. Management of public universities in Rivers State should promote adequate collaboration at various levels among individuals and between individuals and robotics.
3. Government should assist Management of public universities in Rivers State with enough funds to enhance the adoption of these innovations and the relevance of these universities in the 5IR.
4. Management of Public universities in Rivers State should pay adequate attention to the inculcation of relevant skills needed in the 5IR in their students.
5. Management of Public universities in Rivers State should carefully introduce relevant innovations needed for sustainable knowledge development in the 5IR in their educational system

References

- Adigun, G. O., Adio, G., & Durodolu, O. O. (2024). Innovation and skills needed for sustainable knowledge systems in the 5th industrial revolution: Implications for libraries and their users. In K. Sacco, A. Norton, & K. Arms (Eds.), *Navigating AI in academic libraries: Implications for academic research* (pp. 290–307). IGI Global.
- Akçayır, M., Akçayır, G., Pektaş, H. M., & Ocak, M. A. (2016). Augmented reality in science laboratories: The effects of augmented reality on university students' laboratory skills and attitudes toward science laboratories. *Computers in Human Behavior*, *57*, 334–342. <https://doi.org/10.1016/j.chb.2015.12.054>
- Aslam, F., Aimin, W., Li, M., & Rehman, K. U. (2020). Innovation in the era of internet of things and industry 5.0: Absolute innovation management (AIM) framework. *Information*, *11*(2), Article 124. <https://doi.org/10.3390/info11020124>
- Becker, G. S. (1964). *Human capital: A theoretical and empirical analysis, with special reference to education*. Columbia University Press.
- Boer, H., & During, W. E. (2001). Innovation, what innovation? A comparison between product, process and organisational innovation. *International Journal of Technology Management*, *22*(1–3), 83–107.



- Breque, M., De Nul, L., & Petridis, A. (2021). *Industry 5.0: Towards a sustainable, human-centric and resilient European industry*. European Commission. <https://doi.org/10.2777/308407>
- Garzón, J. (2021). An overview of twenty-five years of augmented reality in education. *Multimodal Technologies and Interaction*, 5(7), Article 37. <https://doi.org/10.3390/mti5070037>
- Grabowska, S., & Saniuk, S. (2023). Knowledge and skills development for implementing the industry 5.0 concept. In *Proceedings of the 24th European Conference on Knowledge Management (ECKM 2023)*. Academic Conferences International.
- Gürdür Broo, D., Kaynak, O., & Sait, S. M. (2022). Rethinking engineering education at the age of industry 5.0. *Journal of Industrial Information Integration*, 25, Article 100311. <https://doi.org/10.1016/j.jii.2021.100311>
- Labhane, S., Indumathy, R., Krishnamoorthy, P., Lakshavi, K., & Vincent, J. (2024). Big data analytics in education: Transforming students' learning and institutional practices. *Cahiers Magellanes-NS*, 6(2), 5214–5226. 
- Lamri, J., & Lubart, T. (2023). Reconciling hard skills and soft skills in a common framework: The generic skills component approach. *Journal of Intelligence*, 11(6), Article 107. <https://doi.org/10.3390/jintelligence11060107>
- Mattila, V., Gauri, P., Dwivedi, P., & Dadhich, D. (2022). The fifth industrial revolution: Enlightenment of 5IR towards industry 5.0. *International Journal of Creative Research Thought*, 10(3), 174–182.
- Nahavandi, S. (2019). Industry 5.0—A human-centric solution. *Sustainability*, 11(16), Article 4371. <https://doi.org/10.3390/su11164371>
- Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company: How Japanese companies create the dynamics of innovation*. Oxford University Press.
- Ofor-Douglas, S. (2023). Managing innovative university education for the attainment of sustainable development goals in Nigeria. *East African Journal of Arts and Social Sciences*, 6(1), 156–166.
- Poláková, M., Horváthová Suleimanová, J., Madzík, P., Copuš, L., Molnárová, I., & Polednová, J. (2023). Soft skills and their importance in the labour market under the conditions of Industry 5.0. *Heliyon*, 9(8), Article e18670. <https://doi.org/10.1016/j.heliyon.2023.e18670>



- Rieckmann, M. (2018). Learning to transform the world: Key competencies in education for sustainable development. In A. Leicht, J. Heiss, & W. J. Byun (Eds.), *Issues and trends in education for sustainable development* (pp. 39–59). UNESCO Publishing.
- Schultz, T. W. (1961). Investment in human capital. *The American Economic Review*, 51(1), 1–17.
- Singh, S., Kaur, A., & Gulzar, Y. (2024). The impact of augmented reality on education: A bibliometric exploration. *Frontiers in Education*, 9, Article 1458695. <https://doi.org/10.3389/educ.2024.1458695>
- UNESCO. (2017). *Education for sustainable development goals: Learning objectives*. UNESCO Publishing. <https://unesdoc.unesco.org/ark:/48223/pf0000247444>
- Wang, D., & Barabási, A.-L. (2021). *The science of science*. Cambridge University Press.
- Xu, M., David, J. M., & Kim, S. H. (2018). The fourth industrial revolution: Opportunities and challenges. *International Journal of Financial Research*, 9(2), 90–95. <https://doi.org/10.5430/ijfr.v9n2p90>
- Yeboah, A. (2023). Innovation process model: An integration of innovation costs, benefits, and core competence. *Cogent Business & Management*, 10(1), Article 2176445. <https://doi.org/10.1080/23311975.2023.2176445>