Readiness of Graduates from Ugandan Higher Institutions of Learning for Work in the Fourth Industrial Revolution

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https://doi.org/10.58653/nche.v11i2.6

(Accepted: 19 January 2024, Published: 2 February 2024)

Abstract

For all developing countries, the workforce for the future is at the heart of the development conundrum. Therefore, preparing this workforce with the right skills and capabilities should be of utmost importance to universities and institutions of higher learning. To understand the implications of the Fourth Industrial Revolution (4IR) for the future of jobs and to prepare education and training institutions to train the required workforce, this study examined the readiness of graduates from Ugandan institutions of higher learning for work in the 4IR. The study used a cross-sectional research design to investigate the readiness of graduates from Ugandan universities from the perspective of the skills gained from university. Out of 43.75% of the respondents who had heard about the concept of 4IR, most had basic and intermediate knowledge of the technological drivers of 4IR. Furthermore, the results indicate that, overall, the current university curricula in terms of subject content can be ranked in descending order as partially, poorly, moderately, well and excellently addressing the technological drivers of 4IR as opposed to the non-technological drivers, which were ranked in descending order from well addressed, moderately addressed, excellently addressed and partially addresses to poorly addressed. The findings of the study underscore the urgency to adapt higher education curricula to align with the demands of the 4IR. Scholarships and grants for research into the technological and non-technological drivers of 4IR were the more prominent recommendations, followed by redesigning curricula, industry collaboration and internships, public-private partnerships, policy development, and continuous professional development.

Keywords: *Fourth Industrial Revolution; Higher education; Hard skills; Soft skills.*

Introduction

The term "Fourth Industrial Revolution" (4IR) encompasses the profound changes unfolding in the 21st century within society, the economy and technology. This revolution is characterised by the convergence of the physical, digital and biological domains, ushering in increased connectivity, automation, artificial intelligence and innovation (Schwab, 2016). As these transformations reshape various aspects of life, including work and education, they present both significant challenges and opportunities for education systems (Smith, 2021). In the quest to align education with the demands of the evolving 4IR economy, Olaitan and Mavuso (2022) highlight an early recognition of misalignment between the existing Science, Technology, Engineering and Mathematics (STEM) curricula and the skills required by the 4IR economy. This disparity underscores the potential for graduates to lack the relevant competencies needed to thrive in the changing work landscape. Olaitan and Mavuso (2022) and Adnan et al. (2021) suggest that current curricula may not adequately prepare students for the impending 4IR. This lack of alignment becomes

particularly pronounced in fields like engineering, accounting and business management, where rapid technological advancements threaten the relevance of traditional skill sets. Additionally, these studies point out that some educators might not address critical 4IR skills and career readiness, underscoring the pressing need for curricular reform and innovative teaching methodologies. Looking beyond specific regions, Ndawula et al. (2020) extend the discourse by indicating that the issue of curricular misalignment with 4IR transcends national boundaries. Their study highlights the disconnect between Ugandan engineering university curricula and the demands of the 4IR. This observation accentuates the widespread need for educational systems to adapt to the evolving landscape.

In the quest to realign curricula to match 4IR, Uganda's 4IR strategy (2020) proposes an education ecosystem that provides Ugandans with the skills needed to participate in the economic opportunities of the 4IR. To pursue this goal, the strategy underscores the importance of enhancing teacher and student capabilities through the alignment of the education system with the demands of 4IR (Uganda's National 4IR Strategy, 2020). Specifically, the strategy points out that tertiary institutions are not effectively equipping graduates with the knowledge, skills and capabilities needed to match the emerging demands for participating in the 4IR world of work. The present study is designed to explore and explain the readiness of graduates from Uganda's institutions of higher learning for the world of work in the 4IR. The rationale is to provide the policymakers and other stakeholders with a blueprint for strategic decision-making regarding the implementation and integration of 4IR in teaching and learning, while preparing learners for the world of work. The findings are expected to offer a holistic understanding of how 4IR and its technical drivers and needed skills could be integrated into higher education to equip learners with the required soft and hard skills for the labour market of the 4IR. The following research questions guided the study:

Research questions:

1. Is there content in the current curriculum offered at universities relating to the drivers of 4IR?
2. What soft and hard skills were graduates able to acquire from the current training at university?
3. How relevant are the soft and hard skills to the current work graduates are doing?
4. What suggestions can be put forward for curriculum improvement?

Literature Review

The Fourth Industrial Revolution (4IR) poses significant challenges and offers great opportunities for universities worldwide, and Uganda is no exception. To prepare graduates for the future of work and society, universities need to adopt a transformative approach to higher education that fosters lifelong learning, innovation and adaptability (Singaram et al., 2023). This requires incorporating content related to key 4IR technologies, such as artificial intelligence, biotechnology and blockchain, into curricula, as well as developing the skills and competencies needed to use them effectively. Ugandan universities are making efforts to integrate 4IR content into their programmes, but they face various barriers, such as inadequate infrastructure, funding and faculty capacity (Gamage et al., 2021). A global chorus underscores the urgency of adaptation. Reports like the World Economic Forum's *The future of jobs report 2020* (World Economic Forum, 2020) and UNESCO's *Reimagining education: Learning for the 21st century* (UNESCO, 2021) echo the need for curricula that empower graduates with 4IR skill sets. Uganda's own national vision, articulated in the 2020 4IR Strategy (Uganda National Expert Taskforce, 2020), resonates with this global call, highlighting the importance of aligning universities with the demands of this evolving era. Ugandan universities are implementing various approaches to weave 4IR threads into their academic fabric. Some pioneering institutions, like Makerere University, offer dedicated programmes like the Master of Science in Data Science and Analytics, directly focusing on 4IR themes. Others, such as Mbarara University of Science and Technology, opt for module integration, embedding 4IR topics within existing courses like Robotics and Artificial Intelligence within engineering curricula, while others have done a thorough curriculum review for different course units. Universities in Uganda have enhanced curricula for their academic programmes to prepare their students for the 4IR era, as suggested by Al-Maskari et al. (2024) and Bakhshi and Rouhani (2019). However, a patchwork landscape persists. Atibuni et al. (2022) highlight

a disconnect between certain existing engineering curricula and the demands of the 4IR. Disciplines like social sciences and humanities face hurdles in finding natural connections for these themes, potentially leaving their graduates ill-equipped for the 4IR landscape. Factors like limited faculty expertise, resource constraints and bureaucratic inertia, as identified by Penprase (2018), can further hinder effective integration in some universities.

Soft skills, such as interpersonal and intrapersonal skills, can generate long-term improvements in youth's life outcomes in the 4IR context (Carney et al., 2020). Research shows that soft skills, especially communication, leadership, self-efficacy and networking, are crucial for Ugandan graduates to secure decent employment and succeed in their careers (Nansubuga, 2020). These skills enable graduates to cope with the challenges and opportunities of the 4IR, such as automation, digitalisation and innovation. Ugandan universities are responding to the demand for soft skills by adopting various innovative teaching methods that foster these competencies. Makerere University Business School, for instance, uses an e-learning platform that enables students to access online courses, interact with instructors and peers, and engage in self-directed learning (Bada et al., 2020). These interactive learning strategies help students cultivate communication, teamwork and problem-solving abilities that are essential for succeeding in 4IR careers (Carney et al., 2020). Regular curriculum updates and incorporation of emerging technologies, as recommended by Penprase (2018), are becoming increasingly common. Several studies have confirmed the high demand for soft skills among employers in Uganda, as well as their positive impact on productivity and innovation (Chioda et al., 2021; Gathani et al., 2019; Nampewo et al., 2018). The impact of strong soft skills extends beyond mere employment. Evidence suggests a positive correlation between these skills and job performance, career satisfaction and leadership potential (Hesketh & Kogan, 2016). Ugandan graduates equipped with these skills are more likely to thrive in collaborative environments, effectively resolve challenges, and build strong professional relationships, contributing to enhanced career progress and leadership opportunities.

Hard skills, while valuable, must be considered within the context of Uganda's evolving job market. The relevance of specific technical skills can vary significantly depending on the industry and job demands. Technological advancements can quickly render certain skill sets obsolete, as highlighted by Penprase (2018), necessitating a focus on adaptability and foundational knowledge. This is particularly true for skills heavily reliant on specific software programmes or technologies with rapid replacement cycles. The effectiveness and relevance of 4IR curricula are best understood through the experiences of graduates. ORT's report (2018) delves into the World ORT STEM Communication Project, revealing improvements in confidence, collaboration and problem-solving skills. Similarly, JA Worldwide (2018) showcases the impact of its Company Programme, enhancing entrepreneurial competencies and attitudes among students. Graduates exposed to 4IR curricula demonstrate enhanced employability and adaptability (Ismail et al., 2020). Amihan (2020) underscores how higher proficiency in 4IR skills leads to improved career prospects. Oke and Fernandes (2020) acknowledge the scarcity of empirical studies on graduates' experiences with 4IR curricula. Teng et al. (2019) reveal that 4IR curricula in the education sector foster soft employability skills. Al-Maskari et al. (2021) found similar outcomes for Oman's HEIs, with a focus on communication, teamwork, leadership and problem-solving skills. The authors highlight research from various countries, emphasising the varying levels of awareness and readiness for the 4IR era. Strong analytical skills, fundamental engineering principles, and adaptability itself remain in high demand across various sectors (Bakhshi & Rouhani, 2019). A consensus emerges across studies, including Teng et al. (2019), Al-Maskari et al. (2021) and Yeoh et al. (2023), on the imperative of cultivating competencies that align with the tenets of the 4IR. These competencies span critical domains such as creativity, critical thinking, problem-solving, digital literacy and socio-behavioural skills. Teng et al. (2019) advocate a learner-centred approach that seamlessly incorporates technology into education, while Al-Maskari et al. (2021) stress the need for comprehensive curricular overhauls in higher education institutions (HEIs). The latter, they argue, should foster interdisciplinary knowledge and equip graduates with the multifaceted skills necessary to navigate the complexities of the 4IR era.

Ensuring that graduates acquire skills aligned with the labour market's needs is paramount. Deloitte Global and the Global Business Coalition for Education (2018) offer a comprehensive framework for businesses to contribute to workforce development for the future. Addressing this concern, the report

outlines four key recommendations for businesses to prepare youth for the 4IR. These include aligning stakeholders' visions and approaches, engaging in public policy, developing effective talent strategies, and strategically investing in workforce skilling initiatives. Notably, the report underscores the significance of incorporating youth perspectives in designing and implementing these strategies to ensure their efficacy and relevance in the rapidly evolving landscape (Deloitte Global & Global Business Coalition for Education, 2018). Ugandan universities must strike a balance between providing industry-specific expertise and fostering transferable skills that allow graduates to readily adapt to changing technological landscapes. Ndawula et al. (2020) provide a stark example of curricular misalignment in Ugandan engineering universities . While the study does not explicitly delve into 4IR competences, it highlights the urgency of integrating 4IR technologies and skills into engineering courses. The authors underscore the need for curricular innovation and recommend comprehensive training for teaching staff to bridge the gap between traditional education and the transformative demands of the 4IR era. Reimagining university curricula is necessary to equip graduates with the necessary skills to thrive in the 4IR landscape. In response to the transformative changes introduced by the 4IR, Oke and Fernandes (2020) emphasise the necessity of nurturing relevant and adaptable competencies within the education sector. They propose a paradigm shift towards a learner-centred pedagogical approach, where technology is seamlessly integrated into the learning process rather than being treated as a peripheral tool. Lee et al. (2020) offer a comprehensive framework that advocates reconceptualising traditional subjects, like physics and biology, and placing greater emphasis on cultivating competencies such as sustainability and computer science. This approach focuses on interdisciplinary integration, problem-based learning, computational thinking and social responsibility, and provides a roadmap for transforming education to better prepare students for the dynamic demands of the 4IR landscape. However, the effectiveness of such curricular reforms relies on the ability to assess students' knowledge and skills. The urgency of this transformation is echoed by Adeosun, Shittu and Owolabi (2022), who indirectly highlight a discrepancy between existing curricula and the skill sets demanded by the 4IR. Bühler et al. (2022) also propose breaking down academic silos through interdisciplinary courses and projects. A case in point is joint initiatives between engineering and agriculture students to develop climate-resilient farming solutions, or collaboration between social scientists and computer scientists to address the ethical implications of emerging technologies. Similarly, Dimmitt (2017) proposes that the classroom walls and textbook knowledge can be enhanced by design projects that simulate real-world challenges through, for example, business students navigating simulated start-ups or engineering students tackling community infrastructure issues. Musisi and Sessanga (2019) emphasise the development of critical thinking, analytical skills and creative problem-solving methodologies by integrating open-ended problems, case studies and debates into existing coursework, and considering utilising virtual reality simulations for immersive problem-solving exercises. According to Bühler et al. (2022), moving away from passive lectures and embracing active learning strategies such as group discussions, simulations, role-play activities and debates are excellent tools for honing communication, collaboration and leadership skills. While implementing structured mentorship and coaching programmes are suggested by Ngongalah et. al., (2021), Raza et al. (2023) advocate the fostering of collaboration between universities, industry partners and government agencies as a means to unlock critical knowledge sharing and resource allocation, and the development of curricula tailored to emerging 4IR needs in Uganda. It is also clearly stated and emphasised in Uganda's National 4IR Strategy (2020) that curricula should be regularly evaluated and updated to ensure continued relevance and effectiveness.

Theoretical Review

Al-Harthi (2011) asserts, on the basis of the human capital theory, that attainment of graduates' readiness for employability skills is the responsibility of the formal education, therefore graduates must have the right set of skills for the world of work. Similarly, Al Hinai et al. (2020) used the human capital theory to analyse graduates' readiness for employability and conclude that new technological developments have a great impact on the employability skills of graduates, and thus there is an emerging need for graduates to master the new skills for the emerging world of work. The study is based on the conceptual model shown in Figure 1, proposed by Kamaruzaman et al. (2019).

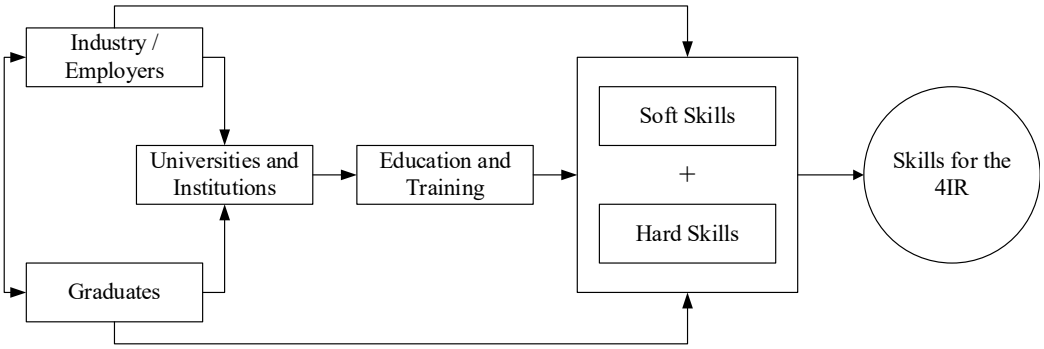

Figure 1. Theoretical model (adapted from Kamaruzaman et al. (2019))

The model in Figure 1 illustrates the relationship between employer (industry) and the education system (university and institution). Universities produce graduates who possess the necessary knowledge and skills required by industry. This essentially means that universities are responsible for producing graduates with the right skills sets that benefit the industry. Therefore, universities and institutions should align their curricula with the latest advancements in technology. The industry should, therefore, work with universities and institutions to design curricula that equip graduates with the required soft and hard skills needed for the 4IR.

Methods and Materials

The study used a descriptive cross-sectional research design to investigate the readiness of graduates from Ugandan universities from the perspective of the skills gained from university. In this study, the target population was comprised of both undergraduate and postgraduate students from selected Ugandan universities. Of these, 46.1% had graduated in the 2022/2023 academic year while 38.3% had graduated in the years 2017–2021. The sampling method used was non-probabilistic and targeted graduates who had completed university. A total of 130 respondents from both public and private universities responded to the online survey questionnaire that was shared. The questionnaire was designed using Google Forms and sent to the respondents via WhatsApp Messenger and email. This approach was adequate to give a holistic interpretation of the skill sets obtained by graduates irrespective of the university they attained. To address the issues of understandability of 4IR, a support question was added to the questionnaire that asked the respondents whether they had heard about the concept of 4IR.

The questionnaire had two parts, A and B. Part A contained items related to student demographics. Part B contained subsections that included questions related to knowledge about drivers of 4IR skills acquired, the use of the acquired skills in job placements and suggestions for curriculum improvement. The questionnaire was validated to enhance the reliability and ensure that it covered all the relevant aspects of the study. The knowledge about the drivers of 4IR was evaluated on the scale of novice to expert. The extent to which the current university curricula address the drivers of 4IR was rated on a scale of 1to 5, with 1 representing poorly addressed, 2 partially addressed, 3 moderately addressed, 4 well addressed and 5 excellently addressed. The effectiveness of the soft and hard skills to the current job assignments was also rated on a scale of 1to 5, with 1 representing ineffective, 2 moderately effective, 3 effective, 4 very effective and 5 highly effective. To abide by research ethics, before answering the questionnaire, respondents were asked to consent to participation in the study.

Data was analysed using Python pandas, matplotlib libraries. The analysis majorly focused on characterising the level of knowledge of 4IR, the soft and hard skills acquired, the relevance of the acquired skills in their current work, and suggestions and recommendations for curriculum improvement.

Results

A total of 128 respondents responded to the survey questionnaire, and out of these 80% possessed bachelor's degrees, 13% master's degrees and 7% doctoral degrees. These graduates had graduated from various fields, as shown in the table below.

Table 1. Fields of study of graduates

Field of study	Total respondents		Heard of 4IR	
	No.	%	No.	%
Computer Science and Information Technology	58	45.3	27	48.2
Business and Management	48	37.5	19	33.9
Others	13	10.2	5	8.9
Engineering and Technology	4	3.1	3	5.4
Education	3	2.3	2	3.6
Arts and Humanities	1	0.8	0	-
Human Medicine and Pharmacy	1	0.8	0	-
Total	128	100	56	100

As shown in the table, most respondents who responded to the survey were graduates of computer science and information technology, followed by those business and management. To lay the foundation to answer the first research question, we asked respondents whether they had heard about the concept of 4IR. The result was that only 56 of the respondents had heard about the concept of 4IR.

Figure 2. Word cloud showing level of familiarity with knowledge of 4IR

There is still need for awareness of the existence of 4IR. The level of familiarity with knowledge of the drivers of 4IR is shown in Figure 2. The majority (39.2%) had basic awareness, followed by intermediate at 25.7%, while 16.1% had advanced knowledge and 13.4% were not familiar at all with the drivers of 4IR. Those who had expert knowledge were only 5.5%. As shown in Figure 2, overall, most respondents showed that they had basic knowledge of 4IR technological drivers, followed by intermediate and advanced. There were few respondents who were novice and experts.

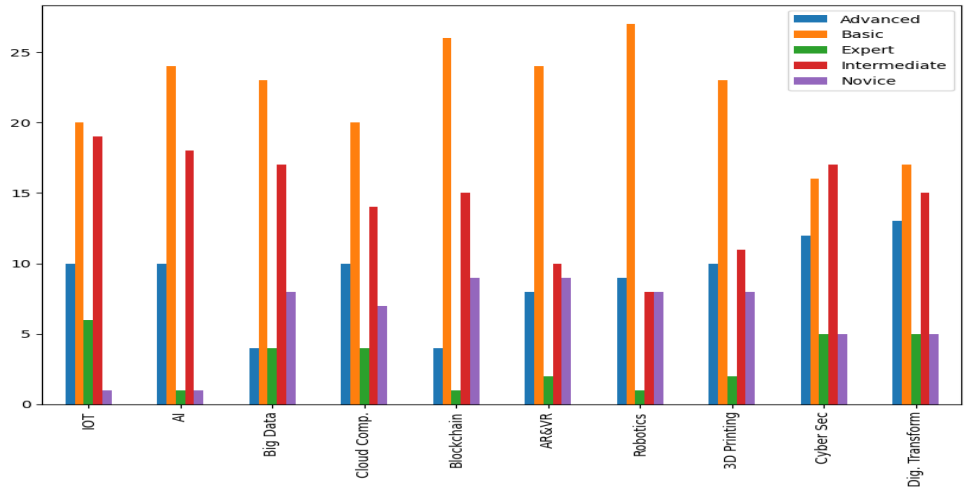

Figure 3. Level of knowledge of each 4IR technological driver

As shown in Figure 3, respectively, robotics, blockchain and AI had the biggest number of respondents with basic knowledge, while the Internet of Things (IoT), artificial intelligence (AI), big data and cybersecurity had the biggest number of respondents with intermediate knowledge. The 4IR driver that had the most novice respondents was blockchain and augmented reality (AR) and virtual reality (VR). IoT, cybersecurity and digital transformation had the most respondents, indicating they had expert knowledge.

Figure 4 shows the extent to which university curricula address the technological drivers of 4IR.

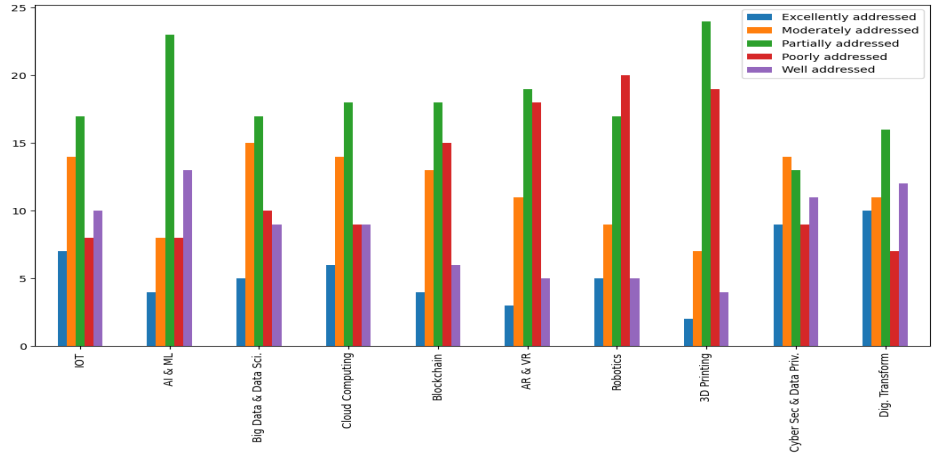

Figure 4. Extent of how curricula address technological drivers of 4IR

Regarding how effectively the university curriculum addresses the subject content of 4IR, overall, the curriculum can be ranked in descending order as partially, poorly, moderately, well and excellently addressing the drivers of 4IR. This is shown in Table 2 below. In the table, the percentage is the overall percentage for all the technological drivers and the mean is the aggregated mean of all responses on the extent of address for each technological driver.

Table 2. Extent of how curricula address the technological drivers of 4IR

Extent of address	Overall percentage (%)	Mean
Partially addressed	32.5	18.20
Poorly addressed	22.0	12.30
Moderately addressed	20.7	11.60
Well addressed	15.0	8.40
Excellently addressed	9.8	5.50

Despite this, the results show that blockchain, AR and VR, robotics and three-dimensional (3D) printing rank top amongst those that are poorly addressed. Amongst the technological drivers that are well addressed, digital transformation ranks top, followed by AI and machine learning (ML), and cybersecurity and data privacy. Big data and data science, IoT and cloud computing rank top under moderately addressed technological drivers. The drivers that were ranked top in the excellently addressed category are digital transformation and cybersecurity and data privacy.

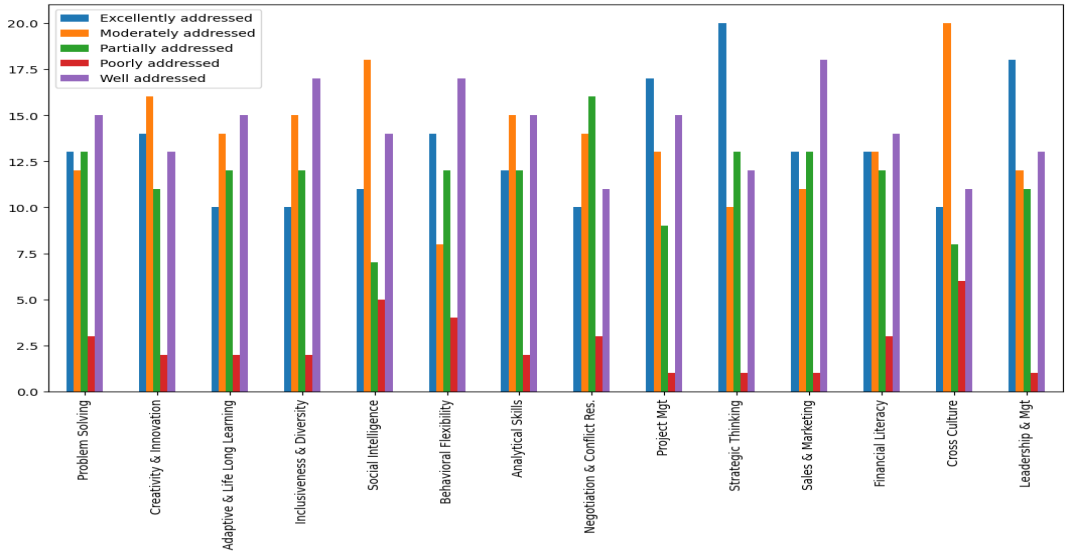

Figure 5. Extent of how curricula address non-technological drivers of 4IR

This result contrasts the way the curriculum addresses the technical drivers. This means that Ugandan universities have to a great extent focused on the non-technical drivers of 4IR. As shown in Figure 5, strategic thinking, leadership and management, project management, behavioural flexibility, and creativity and innovation were reported to be top among those skills which are excellently addressed by the curriculum. In the category of the skills reported as being well addressed, sales and marketing was ranked top, followed by behavioural flexibility and inclusiveness and diversity, problem-solving, adaptive and lifelong learning and analytical skills, respectively. Cross-culture topped the skills that were moderately addressed, followed by social intelligence, creativity and innovation, inclusiveness and diversity, and analytical skills. Negotiation and conflict resolution toped the partially addresses skills, followed by strategic thinking, problem-solving, and sales and marketing, respectively. Cross-culture topped the poorly addressed skills, followed by social intelligence and behavioural flexibility, respectively.

Overall, the results indicate that the non-technological drivers of 4IR can be ranked in descending order from well addressed, moderately addressed, excellently addressed and partially addressed to poorly addressed, as shown in Table 3. The overall percentage is the aggregated percentage of all responses on the non-technological drivers of the 4IR and the mean is the aggregated mean of all responses of each driver on the extent of how the curricula address it.

Table 3. Extent of how curricula address the non-technological drivers of 4IR

Extent of address	Overall percentage (%)	Mean
Well addressed	25.9	14.3
Moderately addressed	24.7	13.6
Excellently addressed	23.9	13.2
Partially addressed	20.8	11.5
Poorly addressed	4.7	2.6

Though the results indicate partially addressed for technical drivers and well addressed for the non-technological drivers, graduates were able to indicate the skills that they acquired during their training at university. These skills were categorised into soft and hard skills. In the soft skills category, communication topped the list at 11.5%, followed by teamwork and collaboration at 11.1%, creativity and innovation at 10.7%, critical thinking at 9.8%, time management at 9.6% and networking and relationship building at 9.4%. The word cloud in Figure 6 shows acquired soft skills. The size of the skills in Figure 6 corresponds to the percentage, i.e. the higher the percentage, the bigger the size in the world cloud. The reverse is true. Good listening skills, customer care relations and problem awareness were least ranked, each at a percentage of 0.2%.

Figure 6. Acquired soft skills from university curricular

Decision-making ranks top among the hard skills at 12.3%, followed by digital skills at 11.1%, innovation management at 10.2%, project management at 9.7%, job-specific expertise at 9.1% and strategic thinking at 8.9%, as shown in Figure 7. Among the least ranked were language proficiency and industry/sector knowledge, both at 6.9%.

Figure 7. Acquired hard skills from university curricula

The study also investigated how effective the acquired skills had been applied in the graduates' current job assignments. This is shown in the table below.

Table 4. Effectiveness of acquired skills in the current job assignments

Effectiveness	Soft skills (%)	Hard skills (%)
Very Ineffective	8.9	3.6
Ineffective	0	1.8
Moderately Effective	26.8	25.0
Effective	42.9	51.8
Highly effective	21.4	17.9

As shown in Table 4, both soft skills and hard skills acquired from university curricula are largely shown to be effective in the graduates' current job assignments. The cumulative effectiveness for the skills were 91.1% and 94.7% respectively for soft and hard skills. Despite the high rate of effectiveness of the skills acquired, the respondents gave several suggestions for improving the curriculum. Using thematic analysis, these were categorised and ranked as shown in Table 5.

Table 5. Suggestions for improving the curriculum

Suggestions for curriculum	Count	%
Introduce more specialised courses on emerging technologies like AI, IoT, blockchain etc.	41	9.3
Incorporate practical hands-on projects and real-world industry experiences.	38	8.6
Provide opportunities for students to work on cross-cultural projects and gain global exposure.	36	8.2
Collaborate with industry partners for guest lectures, internships and industry-driven projects.	35	8.0
Offer more interdisciplinary programmes to foster collaboration between technology and other fields.	34	7.7
Include ethics and societal implications of 4th IR technologies in the curriculum.	32	7.3
Encourage research and innovation through university-industry partnerships.	30	6.8
Develop courses on cybersecurity to address the growing concern of cyber threats.	30	6.8
Establish innovation hubs or incubators for students to work on their entrepreneurial ideas.	29	6.6
Enhance data analytics and data science components in various disciplines.	28	6.4
Integrate soft skills development into the curriculum, including communication and leadership training.	28	6.4
Include more interdisciplinary courses to foster cross-functional skills and adaptability.	28	6.4
Offer continuous upskilling and reskilling opportunities to keep pace with fast-changing technology.	26	5.9

Create flexible and customisable tracks to cater to individual interests and career aspirations.	22	5.0
Provide more time to students while undertaking internship.	3	0.7

Several interventions by government and educational institutions to support graduates to acquire more skills relevant to the world of work in 4IR are listed in the word cloud in Figure 7.

As shown in Figure 8, scholarships and grants for research into the technological and non-technological drivers of 4IR was more prominent at 82.1%, respectively, followed by redesigning the curriculum with a percentage rank of 73.2%, industry collaboration and internships at 66.1%, public-private partnerships ranked at 64.3%, policy development and continuous professional development both ranked at 57.1% and regulatory support was least ranked, at 50%.

Figure 8. Interventions by government and educational institutions

Discussion

4IR represents a significant shift in the way society operates, intertwining the physical, digital and biological realms. The educational sector faces the challenge of adapting to this revolution by aligning curricula with the evolving needs of the workforce. The study identified a notable gap between existing curricula and the skills required in the 4IR economy. This aligns with the study of Mkhize et al. (2020), which revealed that the prevailing curriculum and assessment policies prioritise content knowledge over pedagogical skills, critical thinking and innovation. In Uganda, as in many other countries, there is a need for educational systems to bridge this gap by integrating 4IR technologies and skills into various courses. The study highlighted a lack of awareness among graduates regarding the 4IR concept, emphasising the necessity for increased educational efforts and public discourse surrounding 4IR and its implications. The survey results reveal that while the technical aspects of 4IR are partially addressed in the curriculum, non-technical drivers such as strategic thinking and leadership are relatively well-addressed. However, there is room for improvement, especially in addressing specific 4IR technologies like blockchain, AR, VR and robotics. Soft skills, particularly communication, teamwork and collaboration, were reported to be the most acquired skills from university curricula. This closely aligns with the findings of Poláková (2023) that revealed that within technologically driven domains, there is a discernible demand for soft skills, such as critical and analytical thinking, problem-solving, communication skills and creativity with flexibility. In contrast, decision-making and digital skills were identified as the top acquired hard skills. Moreover, the acquired skills were deemed highly effective in graduates' current job assignments. This does not differ from the findings of Acosta-Garcia (2018), where it was concluded that a good understanding of every professional's own discipline forms the basis for job performance, However, professionals should have curiosity and motivation to continue lifelong learning because everyday life requires working effectively and communicating with people from different backgrounds. Particularly when developing technology for human use, the synergy of work with people from different disciplines and backgrounds is key. The study also highlights that for purposes of effectively preparing graduates for 4IR, the current curricula

at university should be redesigned. As Formunyam (2020) emphasises, the African higher education curricula should be responsive with the ability to produce graduates able to cope with the digitisation of the organisational workspace.

Conclusion

The findings of this study underscore the urgency to adapt higher education curricula to align with the demands of the 4IR. It was graduates of computing and information technology and business and management curricula who had heard of the concept of 4IR as opposed to those who of other curricula. In the arts and humanities as well as human medicine and pharmacy, no responses were recorded. Furthermore, the study revealed that most respondents who had heard about the technological drivers of 4IR had basic knowledge, while very few had expert knowledge. Effectiveness of acquired soft skills was rated by 42.9% of the respondents as being effective while the hard skills were rated by 51.8% as being effective in their current job assignments. The transition to 4IR necessitates a proactive and comprehensive reform in higher education to equip graduates with the skills and competencies required for success in the evolving world of work. The role of educational institutions, government and industry collaboration is pivotal in achieving this objective and fostering a workforce ready for the challenges and opportunities of 4IR.

Recommendations

While progress has been made, there is a need for a more comprehensive integration of 4IR technologies and skills into the educational system, particularly in technical domains like blockchain and robotics. To enhance the preparedness of graduates, the study recommends incorporating specialised courses on emerging technologies, fostering practical experiences, encouraging collaboration with industry partners, and emphasising interdisciplinary programmes. Furthermore, integrating ethics and societal implications of 4IR technologies, nurturing entrepreneurship and continuously upskilling students are vital strategies. Government and educational institutions need to play an active role in facilitating these changes by providing scholarships, redesigning curricula, encouraging industry collaboration, and offering continuous professional development opportunities. A holistic approach involving all stakeholders is crucial in ensuring that graduates are adequately prepared for the dynamic 4IR job market.

Limitations

The study has the following limitations:

(i) The study majorly focused on graduates. Further studies should focus on the current students and lecturers at universities. The study also focused on graduates from only Ugandan universities, leaving out those who graduated from universities outside Uganda. A comparative study between graduates from Uganda and those from other countries is a niche area of further study.

(ii) The study was based on the opinions of the graduates and did not examine the curricular content. Further studies should critically examine the contents of the curricula. The study neglects the role of other stakeholders, such as employers, government and the private sector, in shaping the 4IR workforce.

(iii) The study focused primarily on skills acquired through university curricula and their effectiveness in current job assignments. It did not delve deeper into other factors that influence employability and career readiness, such as internship experiences, work ethic, industry-specific knowledge, and soft and hard skills beyond those measured in the study.

(iv) The study did not take into consideration factors that affect the teaching and learning processes in Ugandan universities such as the availability of technology, limited infrastructure and access to technology.

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