Business Education Journal
Volume 9 Issue I
Email: jeditor@cbe.ac.tz
Published Online October 2023 in http://www.cbe.ac.tz/bej

EVALUATING THE EXTENT OF ADOPTION AND INTEGRATION OF ARTIFICIAL INTELLIGENCE CONTENT INTO COMPUTING CURRICULA IN HIGH EDUCATION INSTITUTIONS IN TANZANIA: A FOCUS ON THE DESIGN AND DELIVERY OF ACADEMIC PROGRAMMES

Deogratius Mathew Lashayo*,
Department of Mathematics and Actuarial Studies, The Institute of Finance Management (IFM)
Email: deogratius.lashayo@ifm.ac.tz
Julius Raphael Athman Mhina,
Department of Computer Science, The Institute of Finance Management (IFM)
Email: julius. raphael@ifm.ac.tz
*Corresponding author

ABSTRACT

Profound knowledge and skills related to Artificial Intelligence (AI) will be an enabler in promoting product manufacturing and service delivery in the fourth industrial revolution. The fundamental institutions mandated to provide knowledge and skills, such as AI, are Higher Educations Institutions (HEIs). Most HEIs are expected to provide knowledge and skills through the academic programmes they offer. However, the extent of incorporation of AI content during the designing and delivering educational programmes in HEIs in Tanzania is little known. Therefore, this study aimed to evaluate the extent of adoption and integration of AI content in computing curricula in HEIs in Tanzania. It employed a purposive sampling technique to select ten (10) HEIs. The results indicated that the incorporation of AI content into computing (ICT-related) programmes is low (i.e., less than 16.6% of all total taught modules) at undergraduate and graduate levels, while 60% of ICT-based instructors have only 25% of required knowledge and skills to deliver AI-based modules. Surprisingly finding revealed that no HEIs in Tanzania have designed an explicitly AI-based programme. The value of this study lies in informing different stakeholders and the entire public of the extent of incorporation of AIs in the design and delivery of computing programmes in HEIs, specifically in Tanzania.

Keywords: Artificial Intelligence (AI), Higher Education Institutions (HEIs), Curricula, Academic Programmes, Tanzania

How to cite this paper: Lashayo, D. (2023). Evaluating the Extent of Adoption and Integration of Artificial Intelligence Content Into Computing Curricula in High Education Institutions in Tanzania: A Focus on the Design and Delivery of Academic Programmes. Business Education Journal (BEJ), Volume 9(1): 1 – 21 Pages. www.cbe.ac.tz

1. INTRODUCTION

There has been a proliferation of emerging technologies since 2016 (Effoduh, 2016). These technologies attributed to the emergence of another era in the industrial revolution called the fourth industrial revolution, commonly referred to as 4IR (Effoduh, 2016; Xing et al., 2010; Xing & Marwala, 2017a, 2017b). Examples of technologies that constitute 4IR include Artificial Intelligence, Blockchain, Cloud Computing, Machine Learning, Big Data Analytics, Augmented Reality, and 3D printing, to mention the least (Koblentz, 2020; Magruk, 2021; Venter, 2020). These emerging technologies and their applications brought about significant changes in the production of goods and delivery worldwide.

Artificial Intelligence (AI) is regarded as developing a machine that imitates/mimics the intelligence of a human being, learning from experience and making rational decisions (Bhatnagar, 2020). AI is among the leading technologies that brought up a significant revolution in human activities. It is integral to human activities like providing intelligent household applications, smartphones, Google, Siri, and computer games (Burgsteiner et al., 2016; Temitayo Sanusi, 2021). AI further paved the way for Machine Learning (ML) and Deep Learning (DL) (Aggarwal et al., 2022; Barragán-Montero et al., 2021; Iqbal et al., 2021; Wäldchen & Mäder, 2018).

For AI to be formally propagated to the community, the knowledge and skills must be systematically designed and transferred from accredited institutions to the community of learners. Traditionally Higher Education Institutions (HEIs) are common entities worldwide, with several resources for sharing knowledge and skills. HEI is regarded as a tertiary education institution given authority by governing bodies to train and award graduates with different levels such as basic-technician certificates, technician certificates, bachelor-degree certificates, masters-degree certificates, and PhD-degree certificates (Lashayo & Mhina, 2021, 2022; Mushi & Lashayo, 2022).

The world has witnessed different revolutions in past industrial revolutions, each driven by specific characteristics. For example, the first industrial revolution (1IR) was powered by steam in the 8th century, and the second industrial revolution (2IR) was characterised by production in manufacturing powered by electricity. In contrast, computers were powered by the third industrial revolution (3IR). These industrial revolutions have brought changes in social and economic by raising production, and many societies prospered. The current era is regarded as the fourth industrial revolution (4IR), which was expected to be stronger and have a more significant impact than the previous eras (Mir et al., 2020). AI, one of the technologies in 4IR, is expected to be more substantial and more significant in 41R (Mir et al., 2020). Sunder Pichai, the CEO of Google, emphasised this desired outcome in San Francisco in 2018 by saying that AI will bring an impact bigger than electricity and fire (Clifford, 2018).

Many people know the devices and services provided by AI. However, only some knew the technology behind AI (Burgsteiner et al., 2016). Many graduates of computing-based academic

How to cite this paper: Lashayo, D. (2023). Evaluating the Extent of Adoption and Integration of Artificial Intelligence Content Into Computing Curricula in High Education Institutions in Tanzania: A Focus on the Design and Delivery of Academic Programmes. Business Education Journal (BEJ), Volume 9(1): 1 – 21 Pages.
www.cbe.ac.tz

programmes must have significant knowledge and skills to build AI products and services (Burgsteiner et al., 2016). This may be achieved by integrating AI learning outcomes into current curricula in these HEIs. Recent research shows insignificant (inadequate) topics and programmes in lower levels of education, i.e., secondary level (Burgsteiner et al., 2016); further studies show that developed countries like the USA, and Australia, to mention a few, have made a significant improvement in their designing of curricula and delivery of it (Dec et al., 2022a; Featherston et al., 2014; Holmes et al., 2020). However, little is known about the extent of incorporation of AI technologies in the context of design and delivery for most HEIs in developing countries (Lin & Van Brummelen, 2021; Sanusi, 2021; Temitayo Sanusi, 2021), particularly for Tanzania.

Furthermore, there is a considerable number of studies on how the instructors are equipped and prepared for delivering AI content in developed countries such as Germany (Lindner et al., 2019; Lindner & Berges, 2020), while there is a lack of same studies in developing countries such as Tanzania. Therefore, this study intends to answer the following central question, to what extent is AI adopted and integrated into the design and delivery of HEIs curricula in Tanzania? The main question of this study will be broken down into these specific questions:

RQ1: To what extent do computing-related curricula contain modules related to AI in HEIs?

RQ2: To what extent do HEIs offer academic programmes explicitly for AI?

RQ3: To what extent are instructors in HEIs equipped with skills and knowledge related to AI?

This research is important to show how HEIs, particularly in developing countries, have positioned themselves to support the designing and delivering AI content as an emerging technology. AI has been important technology today than ever, and many tertiary students would love to master it, especially those who are taking computing programmes (Temitayo Sanusi, 2021). Knowing how academic curricula have been designed and delivered in higher education institutions is important. Also, knowing how instructors are equipped with AI content is important. This study has set forth these objectives to evaluate AI content integration in the fourth industrial revolution. Furthermore, this study will be useful to people interested in AIs, including researchers, developers, educators, students, funders, and policy-makers.

The next sections proceed as follows; section 2 describes the background of AI technology, section 3 describes the population and sampling procedure, and Section 4 describes data analysis. Additionally, section 5 describes the results, while a detailed analysis of the results, implications, conclusion and suggestions for future studies are provided in section 6.

2. LITERATURE REVIEW

This section reviews the literature on artificial intelligence as a fourth industrial revolution (industry 4.0) technology. It also reports the evolution of AI and its acceptance in HEIs.

2.1 Background of Artificial Intelligence

The concept of AI started in 1950 when a discussion of thinking machines happened (Mir et al., 2020). One of the scientists who engaged in that discussion and implementation of the thinking machine was Alan Mathison Turing, a mathematician and computer scientist, and he published his research findings in which he proposed and tested a device that responds like a human being (Alan, 1950.; Turing & Haugeland, 1950). This was the first attempt to establish a machine to think and make rational decisions like a human.

Since 1950, the conceptualisation and implementation of artificial intelligence have gone through several paradigms. In 1955, John McCarthy, who is also regarded as the father of AI (Rajaraman, 2014, 2016), launched a project which is referred to as "Artificial Intelligence," which was aimed to test how computers can be programmed to use a language, conduct self-improvement, perform randomness selection of things (McCarthy et al., 2006). The definitions and understanding of AI continued to evolve around the concept of thinking machine; current AI is defined as the induction of human intelligence into the machine to perform reasoning, learning, and adaption (Kar, 2016; Nilsson, 1982).

The outcomes of artificial intelligence systems are further considered to be reasoning, computation, perception, and action (Pannu, 2015). Those outcomes in AI do not entirely belong to computer science but take other domains such as mathematics, philosophy, linguistics, information engineering, and psychology (Mir et al., 2020). AI, as technology, when built inside a device, is regarded as a robot. These robots (intelligent autonomous systems) have several applications across many sectors, including manufacturing, mining, education, healthcare support, and agriculture, to mention the least (Sarker et al., 2021).

2.2 Relationship between Artificial Intelligence, Machine Learning, and Deep Learning

In this context, artificial intelligence enables machines or computers to think. In thinking, it reasons out, computes, and perceives by considering a given context and, later, makes a rational decision.

Machine learning is a subset of artificial intelligence that provide tools to explore and analyse data (Aggarwal et al., 2022; Barragán-Montero et al., 2021). In machine learning, there are three approaches: Supervised Machine Learning, Reinforcement Machine Learning, and Unsupervised Machine Learning (Aggarwal et al., 2022; Iqbal et al., 2021). In Supervised Machine Learning, a developed algorithm model works on past-labelled data, while in Un-supervised Machine Learning, an algorithm model works on un-labelled past data. Finally, in the last approach, Semi-supervised/Reinforcement Machine Learning, an algorithm operates on labelled and unlabelled data streams (Wäldchen & Mäder, 2018).

Deep learning is another sub-category of machine learning. This technology mimics the human brain (Wäldchen & Mäder, 2018). Deep learning is made up of an algorithm called Multi-Neural Network Architecture which is an approach using three methods, which are Artificial Neural Network (ANN), Commotion Neural Network (CNN), and Recurring Neural Network (RNN) (Aggarwal et al., 2022). These three approaches are used differently according to the nature of the data. For instance, when data is in the form of numbers, ANN is called an action, whereas when information is in the form of images, then CNN is called into action, and when data is in time series, RNN is engaged.

2.3 Integration of AI Content in Academic Curricula in HEIs

The academic curriculum is the main tool in designing education settings that details what and how learning and teaching will occur. Academic curriculum, according to National Council for Technical and Vocational Education and Training (NACTVET), is usually divided into Principal Learning Outcomes (PLO), Enabling Outcomes (EOs), Sub-enabling outcomes (SEOs), and, lastly, Related Tasks (RTs) (NACTVET, 2023). Principal learning outcomes of the programme detail the main blocks of expected outcomes in the given programme. The enabling outcome breaks down the principal earning outcome, which may result in modules or subjects. The sub-enabling outcome is a set of elements expected normally from the module or subject. This SEO is further divided into groups of tasks that a learner is likely to act on either with maximum or minimum supervision (NACTVET, 2023).

Mir et al. (2020) reported that AI comprises several domains: mathematics, philosophy, linguistics, information engineering, and psychology. With these concepts and the impact expected from the presence of AI in our era, HEIs should introduce modules that relate to HEIs so that learners would have a taste of AI. The literature shows that the basics of AI comprise problem-solving, search, planning, graphs, data structures, automata, agent systems, and machine learning, which are supposed to be taught theoretically and practically (Burgsteiner et al., 2016).

What is being taught in higher education institutions worldwide is a problem to be investigated (Holmes et al., 2020). AI has become integral, pervasive, and inescapable in our everyday life of human being (Burgsteiner et al., 2016). In developed countries, many efforts promote AI in HEIs (Featherston et al., 2014; Holmes et al., 2020; Torrey, 2012). Statistics from Holmes et al. (2020, pg. 3) show that in the United States of America (USA), more than 50% of adults are competent with AI. Currently, the USA is closing to another 36% on top of that 50% (Holmes et al., 2020). The current state of HEIs in designing and delivering AI technology to the public in developing countries, particularly in Tanzania, still needs to be investigated. This research intends to close this gap.

2.4 Development of AI Programmes

Several academic programmes that aim to provide students with AI expertise and skills must be explicitly developed to keep up with the speed and demand of AI technology in our environment. For instance, they have established academic programmes in the USA to equip learners with an AI technology background (e.g. Featherston et al., 2014). It is essential to develop educational programmes from the basic technician to master's degree levels to provide learners with a solid foundation. Irrespective of developing countries having national ICT policies to guide digital development, the HEIs are still working on their strategic plans, which may not uptake the digital adoption and implementation as quickly as expected. For instance, in Tanzania, most of the HEIs are autonomous institutions. Therefore, the number of academic programmes established solely for equipping students with AI technology must be clearly reported and documented in Tanzania. This study is looking forward to addressing this gap.

2.5 Instructors' Competencies in AI

Instructors play a big part in designing and delivering learning content in this AI technology context. Many HEIs have adopted online learning platforms to supplement traditional teaching methods (Lashayo & Mhina, 2021, 2022; Mushi & Lashayo, 2022). Current online research shows that information content is key in affecting students' continuous use of online learning systems (Lashayo & Mhina, 2022; Mtebe & Raphael, 2018). For students to get quality information for their learning path, HEIs should be devoted to equipping instructors with good skills in AI technologies. Without the proper information on the extent of instructors who are interested and able to deliver AI content to students, it would not be easy to transfer this technology to students.

There are a significant number of studies in developed countries regarding the extent of instructors capable of delivering AI content from the secondary to the tertiary level, for instance, studies in Germany in several federal states of Bavaria, Berlin and Brandenburg (e.g. Grillenberger & Romeike, 2017; Lindner et al., 2019; Lindner & Berges, 2020). Also, in New Zealand, there were efforts to understand the extent of equipment of AI skills to instructors (e.g.Thompson et al., 2013). Different from the developed world, the situation in developing countries is different, limited studies were conducted, and they were regional and not specific countries (e.g. Sanusi, 2021). With individual developing countries knowing their status, it will be easier to excel in this emerging technology. Therefore, this research intends to establish the extent of instructors who can facilitate designing and delivering AI programmes in HEIs in Tanzania.

3. METHODOLOGY

This section describes the study philosophy, the intended population, and their respective sample. It further explains how the questionnaire was built and how data were collected.

3.1 Research Design

The design of this study was quantitative and cross-sectional, as it was conducted in October 2022 by associating with public-owned HEIs in Dar es Salaam and Morogoro. The following research questions guided this study:

(1) To what extent are computing-related curricula contain modules related to AI in HEIs?
(2) To what extent do HEIs explicitly provide AI academic programmes?
(3) To what extent are instructors in HEIs equipped with skills and knowledge related to AI?

3.2 Population and Sampling

3.2.1 Population

The population of this study consists of all Higher Education Institutions (HEIs) which are public-owned in Tanzania. It includes those HEIs currently regulated by two government regulators of higher education institutions: NACTVET and TCU. The reason for choosing public-owned institutions is because these institutions get enough support from the government for several resources, including finance, human resources, infrastructures, policy, and training, to list a few.

3.2.2 Sampling and Sampling Size

This study decided to choose the purposive sampling method, which is a non-probability sampling technique. The main reason to apply this sampling technique is the richness of information the selected HEIs are expected to have. A total number of ten (10) institutions participated, including IFM, IAA, TIA, DIT, CBE, UDOM, SUA, MNMA, EASTEC, and UDSM.

3.3 Data Collection and Analysis

The main purpose of this study was to assess the adoption and integration of the content of AIs technology to HEIs in Tanzania. To maintain the unbiasedness and quality of collected and analysed data, the authors collected primary data using a questionnaire to select HEIs. Furthermore, the collected data were validated using a prospectus of the involved HEIs. The questionnaire was made up of four (4) sections. Section A is general information about a given HEIs. Sections B up to D contain information related to AI technology design and delivery, as shown in Appendix A. Collected data were analysed using Microsoft Excel software version 21.

4. RESULTS AND ANALYSIS

This section report processed data (results) and the analysis technique involved.

4.1 Profiles of Respondents

Table 1 shows the demographic characteristics of the sample. A total of 10 questionnaires were returned, with one respondent for each institution. All respondents were males, mostly aged between 35 and 50 (80%). The respondents were custodians of curricula and managers

of academic staff in their respective HEIs, such as the Registrar, Director of Academic Services, Deans of faculties, Director of undergraduate/postgraduate studies, and Heads of departments.

Table 1: Social-Demographic Characteristics of Respondents (N = 10)

Characteristic	Group	Frequency	Frequency (%)
Age	18 to 34	1	10
	35 to 50	8	80
	51 and above	1	10
Total		10	100
Gender	Male	10	100
	Female	0	0
Total		10	100
Education level	Bachelor Degree	1	10
	Master's Degree	4	40
	PhD	5	50
Total		10	100

4.2 Designing of Science or Technology based programmes

The respondents were asked to indicate the presence of IT /CS programmes in their institutions from the basic technician level to the master's degree level. Their responses are summarised in Table 2.

Table 2: Design of Academic Programmes

Programme	No. of Institutions	Average No. of AI Modules
Basic Technician	8	2
Technician Certificate	9	2
Bachelor	10	3
Masters	5	3

The results show that eight of the ten surveyed institutions have a basic technician certificate programme. Furthermore, the results showed that, on average, there are only two (2) modules of artificial intelligence and related technologies among these eight institutions.

Regarding technician certificate programmes (commonly called diplomas), the results show that nine (9) institutions have technician certificate programmes with an average of two artificial intelligence modules in their programmes.

On the other hand, the study showed that all surveyed institutions offer bachelor's degree programmes, and each institution has three artificial intelligence modules on average.

Finally, the survey showed that out of the ten institutions, five have master's degree programmes and an average of three artificial intelligence modules in their programmes.

4.3 Designing of Explicitly Artificial Intelligence Programmes at different levels

The study asked the respondents to indicate the presence of explicit artificial intelligence programmes. Data showed that all survey institutions have no explicit AI Programmes.

4.4 Delivery of Programmes

The study asked the respondents to indicate the total number of full-time staffs in CS/IT modules, the number of instructors with competence in AI or related areas, and how frequently they are taken to short-term and long-term training. The study results (table 3) show that out of ten surveyed institutions, six institutions (which is equivalent to 60%) indicate that there are very few instructors (between 1% and 25%) who have competency in artificial intelligence, two institutions have few instructors (between 26% and 40%) with competence in artificial intelligence. The remaining two institutions showed that 41% to 50% of their instructors are competent in artificial intelligence.

Furthermore, the results show that, on average, only one (1) instructor is provided with short-term and long-term training to update their knowledge.

Table 3: AI Delivery Competency of Instructors

Institution	No. of Employees in IT/CS subjects	No. of Instructors with Competency in AI	Frequency of Training (Short–Term)	Frequency of Training (Long–Term)
CBE	20	between 1% to 25%	0	0
TIA	8	between 1% to 25%	0	0
IFM	20	between 1% to 25%	0	1
EASTC	6	between 1% to 25%	1	0
UDOM	70	between 1% to 25%	1	1
UDSM	90	between 1% to 25%	1	1
DIT	28	between 26% to 40%	0	1
IAA	32	between 26% to 40%	1	1
SUA	42	between 41% to 50%	0	0
MNMA	6	between 41% to 50%	2	2

5. DISCUSSION AND IMPLICATIONS.

5.1 Discussion of key results

Regarding the first research question (**RQ1**), the result indicated that most of the technician programmes (basic technician and technician programme) which are currently offered in HEIs in Tanzania have an average of two (2) modules from a total of twelve modules which are usually provided per each academic year. That ratio is equivalent to 16.6% of total modules. Recent research in Poland, Spain, Greece, and Italy shows that Artificial intelligence is leading, with 48% of its contents being in computing programmes, including optional modules (Dec et al., 2022). This small size of incorporation of AI in Tanzania may be associated with a limited mentality about the application of AI in our everyday business.

Furthermore, on **RQ1**, in bachelor degree programmes in computing programmes, most HEIs provide an average of three modules out of all total modules taught in an entire programme which is slightly less than what universities in developed countries offer; for instance, in the United Kingdom, it is four (BSc., 2022), likewise in masters programmes.

In Brazil, data shows that in twenty-five HEIs, each computer science or related programme offers 20 modules for entire undergraduate programmes (Ferreira et al., 2014), an average of 5 models per four-year programme. Highly world-ranked schools such as Carnegie Mellon University, Massachusetts Institute of Technology (MIT), and the University of California– Berkeley teaches an average of 10 modules per programme(Stewart et al., 2020). The reason for the low number of modules related to AI in a bachelor's degree in Tanzania (summarised in Table 4) may not be different from that stated above at the technician level.

Table 4: Number of AI-related modules in degree programmes

Tanzania	United Kingdom	Highly-ranked HEIs
3	4	10

The second research question (**RQ2**) indicated that the number of programmes explicitly for AI in undergraduate and master's degrees is zero. This means that no HEI have prepared special programmes to equip learners in AI technology, unlikely in developed countries, for instance, in the United Kingdom (UK), whereby records show that in 2017 there were 26 universities offered AIs programmes for undergraduate and more than 30 masters programme (UK, 2018) explicitly. United States of America (USA) and other European countries are pushing for more explicit programmes in AI (Chen, 2020). This shows that HEIs in Tanzania are way back on promoting special programmes for AI, irrespective of the high demand for staff in AI technology. The literature indicates that 93% of organisations in the USA and UK are more than able to apply AI-based solutions in their business, and only 49% of their staff are competent with AI technology(*AI News, 2019*). The reason for not having explicit AI modules may be that HEIs in Tanzania are not treating AI as an essential subject for further development. At the same time, 93% of organisations are eager to incorporate AI-based solutions in their daily business in countries like the USA and UK.

Regarding the extent of delivery (**RQ3**), this study focused on the competency (knowledge and skills) of the main source of AI content and presentation, mostly instructors. The findings indicated that in 40% of instructors in ICT-based programmes in HEIs, their AI competency is above 25%; this implies that in Tanzania, 60% of instructors in ICT-based programmes in HEIs have less competency in AIs than 25%. At the same time, a recent study in Poland, Spain, Greece, and Italy indicated that 80% of instructors could deliver AI-based modules (Dec et al., 2022). Italy, specifically every HEI, has at least one lecturer who can deliver AI modules to the PhD level (Cadoli & Carizzi, 2006). The study found that only a few instructors in Tanzania have competency in AI modules due to few instructors being aware of the importance and role AIs play in daily business for different organisations. Also, finding indicate that there are few pieces of training that HEIs offer to sensitise and build competency to instructors, especially those who have yet to do AI-related modules in their previous education training (refer to Table 3). Table 3 indicates that half (50%) of Tanzania public HEIs do not offer any short courses to their instructors; on the other hand, 40% of HEIs do not provide long periods of AI training.

5.2 Implications for Practitioners

Implication to Practitioners

The few taught modules of artificial intelligence will produce students who are less competent in artificial intelligence technology; therefore, in the long run, the country will be unable to have systems that are different from the conventional information systems, and hence expected performance of the business processes will not be there.

There is also a threat to the employability of graduates from technician level to master's level because most world businesses today are taken over by the application of emerging technologies, particularly artificial technology. Therefore, the country (Tanzania) is on the verge of having a critical problem of un-employability graduates.

6. CONCLUSION, LIMITATIONS AND FUTURE STUDIES

6.1 Conclusion

The main objective of this study was to determine the current extent of adoption and incorporation of the content of Artificial intelligence (AI) technology in Higher Education Institutions (HEIs) in Tanzania by considering its curricula design and delivery of computing programmes. A purposive sample of ten (10) HEIs was selected to carry out such an objective. The study found that the artificial intelligence content currently taught in public-owned HEIs are low (i.e., less than 16.6% of all total taught modules are AI-based modules) which will un-able HEIs to prepare ICT-based graduates to support current business processes worldwide. Furthermore, this study found that no HEIs in Tanzania have an explicit programme for AI, irrespective of the extent of demand for this technology in the current economy (fourth industrial generation). On top of that, the current study revealed that the delivery of existing modules might be hindered by a low number of competent instructors delivering AI modules (i.e., more than 60% of ICT-based instructors have less than 25% of knowledge and skills related to AI).

6.2 Limitations and Future Study

Apart from the success of this cross-sectional study but it is also limited by the following:

It only used a sample from ten (10) HEIs, which are purposively selected; this may somehow limit the findings; therefore, in the future, the authors propose that the same quantitative study use a probability sampling design.

The study scope was constrained to only three research questions. However, more questions may be added on top of these questions, including the inquiry into the details of each AI module so that the researchers would understand the details of each module offered.

The study employed one group of respondents in the HEI setting. However, the other groups, including students and non-academic staff, may contribute to the study's revelation. In the future, the researchers may take these two groups to enrich the results.

In industry 4.0, the needs of the ecosystem are so essential to be considered and integrated into the study; companies (which provide unique problems and challenges), academic institutions (which are continually changing their curricula to meet market demands), and students (learners who are willing to solve real-world situations).

REFERENCES

AI News. (2019). Retrieved 16th November 2022, from https://www.artificialintelligence-news.com/2019/05/21/93-of-firms-committed-to-ai-but-skills-shortage-posing-problems/

Aggarwal, K., Mijwil, M. M., Al-Mistarehi, A.-H., Alomari, S., Gök, M., Alaabdin, A. M. Z., & Abdulrhman, S. H. (2022). Has the Future Started? The Current Growth of Artificial Intelligence, Machine Learning, and Deep Learning. *Iraqi Journal for Computer Science and Mathematics*, *3*(1), 115–123.

Alan, M. (n.d.). Turing. 1950. Computing machinery and intelligence. *Parsing the Turing Test*, 23–65.

Barragán-Montero, A., Javaid, U., Valdés, G., Nguyen, D., Desbordes, P., Macq, B., Willems, S., Vandewinckele, L., Holmström, M., & Löfman, F. (2021). Artificial intelligence and machine learning for medical imaging: A technology review. *Physica Medica*, *83*, 242–256.

Bhatnagar, H. (2020). Artificial Intelligence-A New Horizon in Indian Higher Education. *Journal of Learning and Teaching in Digital Age*, *5*(2), 30–34.

BSc (Honours) Computer Science Full-time 2023/24 | Sheffield Hallam University. (2022). Retrieved 16th November 2022, from https://www.shu.ac.uk/courses/computing/bsc-honours-computer-science/full-time/2023

Burgsteiner, H., Kandlhofer, M., & Steinbauer, G. (2016). Irobot: Teaching the basics of artificial intelligence in high schools. *Proceedings of the AAAI Conference on Artificial Intelligence*, *30*(1).

CADOLI, M., & CARIZZI, D. (n.d.). *TEACHING ARTIFICIAL INTELLIGENCE IN ITALIAN UNIVERSITIES*.

Chen, X. (2020). AI + Education: Self-adaptive Learning Promotes Individualized Educational Revolutionary. *Proceedings of the 2020 6th International Conference on Education and Training Technologies*, 44–47. https://doi.org/10.1145/3399971.3399984

Clifford, C. (2018). Google CEO: AI is more important than fire or electricity. *1st February, Available at Https://Www. Cnbc. Com/2018/02/01/Googleceo-Sundar-Pichai-Ai-Is-More-Important-than-Fire-Electricity. Html (Accessed 6th June 2019)*.

Curriculum Development Procedures – The National Council for Technical and Vocational Education and Training (NACTVET). (n.d.). Retrieved 6th April 2023, from https://www.nacte.go.tz/index.php/curriculum/curriculum-development-procedured/

Dec, G., Stadnicka, D., Paśko, \Lukasz, Mądziel, M., Figliè, R., Mazzei, D., Tyrovolas, M., Stylios, C., Navarro, J., & Solé-Beteta, X. (2022a). Role of Academics in Transferring Knowledge and Skills on Artificial Intelligence, Internet of Things and Edge Computing. *Sensors*, *22*(7), 2496.

Dec, G., Stadnicka, D., Paśko, \Lukasz, Mądziel, M., Figliè, R., Mazzei, D., Tyrovolas, M., Stylios, C., Navarro, J., & Solé-Beteta, X. (2022b). Role of Academics in Transferring Knowledge and Skills on Artificial Intelligence, Internet of Things and Edge Computing. *Sensors*, *22*(7), 2496.

Effoduh, J. O. (2016). *The Fourth Industrial Revolution by Klaus Schwab*.

Featherston, E., Sridharan, M., Urban, S., & Urban, J. (2014). DOROTHY: Enhancing bidirectional communication between a 3D programming interface and mobile robots. *Fifth AAAI Symposium on Educational Advances in Artificial Intelligence*.

Ferreira, P. C., Bernadini, F. C., da Silva, C. R. C., & Viterbo Filho, J. (2014). How Computer Science Undergraduate Programs in Brazilian Public Universities Address Artificial Intelligence and its Topics. *Learn. Nonlinear Model*, *12*, 73–85.

Grillenberger, A., & Romeike, R. (2017). What teachers and students know about data management. *Tomorrow's Learning: Involving Everyone. Learning with and about Technologies and Computing: 11th IFIP TC 3 World Conference on Computers in Education, WCCE 2017, Dublin, Ireland, July 3-6, 2017, Revised Selected Papers 11*, 557–566.

Holmes, W., Bialik, M., & Fadel, C. (2020). *Artificial Intelligence in Education.*

Iqbal, M. J., Javed, Z., Sadia, H., Qureshi, I. A., Irshad, A., Ahmed, R., Malik, K., Raza, S., Abbas, A., & Pezzani, R. (2021). Clinical applications of artificial intelligence and machine learning in cancer diagnosis: Looking into the future. *Cancer Cell International*, *21*(1), 1–11.

Kar, A. K. (2016). Bio-inspired computing–a review of algorithms and scope of applications. *Expert Systems with Applications*, *59*, 20–32.

Koblentz, G. D. (2020). Emerging technologies and the future of CBRN terrorism. *The Washington Quarterly*, *43*(2), 177–196.

Lashayo, D. M., & Mhina, J. R. A. (2021). Antecedents of Instructor Intention to Continue Using E-Learning Systems in Higher Learning Institutions in Tanzania: The Influence of System Quality and Service Quality. *International Journal of Technology-Enabled Student Support Services (IJTESSS), 11*(1), 1–16.

Lashayo, D. M., & Mhina, J. R. A. (2022). Factors Influencing Students' Continuance Intention Toward Usage of E-Learning Systems in Tanzania: The Hybrid of ECM and ISSM Models. *International Journal of Mobile Devices, Wearable Technology, and Flexible Electronics (IJMDWTFE), 12*(1), 1–20.

Lin, P., & Van Brummelen, J. (2021). Engaging teachers to co-design integrated AI curricula for K-12 classrooms. *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, 1–12.

Lindner, A., & Berges, M. (2020). Can you explain AI to me? Teachers' pre-concepts about Artificial Intelligence. *2020 IEEE Frontiers in Education Conference (FIE)*, 1–9.

Lindner, A., Romeike, R., Jasute, E., & Pozdniakov, S. (2019). Teachers' perspectives on artificial intelligence. *12th International Conference on Informatics in Schools, "Situation, Evaluation and Perspectives", ISSEP*.

Magruk, A. (2021). Analysis of Uncertainties and Levels of Foreknowledge about Major Features of Emerging Technologies—The Context of Foresight Research for the Fourth Industrial Revolution. *Sustainability*, *13*(17), 9890.

McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, C. E. (2006). A proposal for the Dartmouth summer research project on artificial intelligence, 31st August 1955. *AI Magazine*, *27*(4), 12–12.

Mir, U. B., Sharma, S., Kar, A. K., & Gupta, M. P. (2020). Critical success factors for integrating artificial intelligence and robotics. *Digital Policy, Regulation and Governance*.

Mtebe, J. S., & Raphael, C. (2018). Key factors in learners' satisfaction with the e-learning system at the University of Dar es Salaam, Tanzania. *Australasian Journal of Educational Technology*, *34*(4).

Mushi, R. M., & Lashayo, D. M. (2022). E-Learning Readiness Assessment on Distance Learning: A Case of Tanzanian Higher Education Institutions. *International Journal of Information Communication Technologies and Human Development (IJICTHD)*, *14*(1), 1–10.

Nilsson, N. J. (1982). *Principles of artificial intelligence*. Springer Science & Business Media.

Pannu, A. (2015). Artificial intelligence and its application in different areas. *Artificial Intelligence*, *4*(10), 79–84.

Rajaraman, V. (2014). John McCarthy—Father of artificial intelligence. *Resonance*, *19*(3), 198–207.

Rajaraman, V. (2016). Big data analytics. *Resonance*, *21*(8), 695–716.

How to cite this paper: Lashayo, D. (2023). Evaluating the Extent of Adoption and Integration of Artificial Intelligence Content Into Computing Curricula in High Education Institutions in Tanzania: A Focus on the Design and Delivery of Academic Programmes. Business Education Journal (BEJ), Volume 9(1): 1 – 21 Pages. www.cbe.ac.tz

Sanusi, I. T. (2021). Intercontinental evidence on learners' differentials in sense-making of machine learning in schools. *Proceedings of the 21st Koli Calling International Conference on Computing Education Research*, 1–2.

Sarker, S., Jamal, L., Ahmed, S. F., & Irtisam, N. (2021). Robotics and artificial intelligence in healthcare during COVID-19 pandemic: A systematic review. *Robotics and Autonomous Systems*, *146*, 103902.

Stewart, J. C., Davis, G. A., & Igoche, D. A. (2020). AI, IoT, AND AIoT: DEFINITIONS AND IMPACTS ON THE ARTIFICIAL INTELLIGENCE CURRICULUM. *Issues in Information Systems*, *21*(4).

Temitayo Sanusi, I. (2021). Teaching Machine Learning in K-12 Education. *Proceedings of the 17th ACM Conference on International Computing Education Research*, 395–397.

Thompson, D., Bell, T., Andreae, P., & Robins, A. (2013). The role of teachers in implementing curriculum changes. *Proceeding of the 44th ACM Technical Symposium on Computer Science Education*, 245–250.

Torrey, L. (2012). Teaching problem-solving in algorithms and AI. *3rd Symposium on Educational Advances in Artificial Intelligence*.

Turing, A. M., & Haugeland, J. (1950). Computing machinery and intelligence. *The Turing Test: Verbal Behavior as the Hallmark of Intelligence*, 29–56.

UK, G. (2018). Industrialstrategy: ArtificialIntelli□ gencesectorDeal. In *2018/ 04/26. Https://www. Gov. Uk/government/publications/artificial intelligence sector*.

Venter, R. (2020). Theologising emerging technologies. *JA. Van Den Berg (Red.). Engaging the Fourth Industrial Revolution: Perspectives from Theology, Philosophy and Education. Bloemfontein: SUN PReSS.(UFS Theological Explorations Series Vol. 3)*, 65–78.

Wäldchen, J., & Mäder, P. (2018). Machine learning for image-based species identification. *Methods in Ecology and Evolution*, *9*(11), 2216–2225.

Xing, B., Gao, W.-J., Battle, K., Marwala, T., & Nelwamondo, F. V. (2010). Artificial intelligence in reverse supply chain management: The state of the art. *ArXiv Preprint ArXiv:1012.4046*.

Xing, B., & Marwala, T. (2017). Implications of the fourth industrial age on higher education. *ArXiv Preprint ArXiv:1703.09643*.

Appendix A: Questionnaire

SECTION A: General information on Higher Education Institutions

SECTION B: Designing of Science or Technology based programmes

1. Do you have basic technician programmes? (YES/NO)
2. If YES, how many average module (s) of AIs in science/technology (IT/CS or related academic programmes) do you have for each basic technician level? (……).
3. Do you have technician programmes? (YES/NO)
4. If YES, how many average module (s) of AIs in science/technology (IT/CS or related academic programmes) do you have for each technician level? (……).
5. Do you have basic degree programmes? (YES/NO)

6. If YES, how many average module (s) of AIs in science/technology (IT/CS or related academic programmes) do you have for each basic degree level? (…….).
7. Do you have master's degree programmes? (YES/NO)
8. If YES, how many average module (s) of AIs in science/technology (IT/CS or related academic programmes) do you have for each master's degree level? (…….).

SECTION C: Designing of Explicitly Artificial Intelligence Programmes at different levels

9. Do you have AI Programmes explicitly for the basic technician level? (YES/NO)
10. If YES, how many …….
11. If YES, how many students do you have on average?
12. Do you have AI programmes for the technician level explicitly? (YES/NO)
13. If YES, how many …….
14. If YES, how many students do you have on average?
15. Do you have AI Programmes explicitly for the primary degree level? (YES/NO)
16. If YES, how many …….
17. If YES, how many students do you have on average?
18. Do you have AI programmes for the master's programme explicitly? (YES/NO)
19. If YES, how many …….
20. If YES, how many students do you have on average?
21. Do you have AI programmes for the master's degree level explicitly? (YES/NO)
22. If YES, how many …….
23. If YES, how many students do you have on average?
24. Do you have AI programmes for the PhD degree level explicitly? (YES/NO)
25. If YES, how many students do you have on average?

SECTION D: Delivery of programmes

26. How many full-time instructors are in science/technology-related programmes?
27. How many instructors are competent with the delivery of AI modules/subjects
28. How frequently are your instructors trained (short-training) in AIs?
29. How frequently are your instructors trained (long-training) in AIs?

Declaration

This work is our study and has yet to be submitted anywhere apart from this journal.