Assessing the integration of AI competencies in undergraduate public administration curricula in selected South African higher education institutions

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Abstract

There is an increasing call to include Artificial Intelligence (AI) competencies in academic disciplines such as Public Administration, which are not obviously related to Science, Technology, Engineering and Mathematics (STEM). However, the literature on the integration of AI in non-STEM curricula in South African higher education institutions (HEIs), especially in Public Administration curricula, is limited. To address this lacuna, this research assessed the integration of AI competencies in undergraduate Bachelor of Administration (BAdmin) curricula in three HEIs randomly selected from the six offering such a programme. The chosen qualitative research approach focused on human and technical competencies. The findings show that AI competencies are not adequately integrated into the Public Administration curricula of the assessed HEIs in the form of core modules supporting AI competencies. These competencies are only loosely supported by elective (optional) modules. This general AI competency gap in the Public Administration curricula of the assessed South African HEIs must be bridged to achieve a digital public sector by introducing focused AI competency training into the BAdmin curriculum. This will help to create a public sector workforce equipped to handle the opportunities and challenges presented by AI, and maximise the potential of this transformative technology.

Keywords: Fourth industrial revolution, artificial intelligence, Artificial Intelligence competencies, curriculum, universities, South Africa

Rapid technological advances are driving a profound global transformation often referred to as the Fourth Industrial Revolution (4IR). This revolution is characterised by advances in Artificial Intelligence (AI), the Internet of Things (IoT), robotics, and other autonomous technologies, and it is reshaping society at an unprecedented pace (Carrim, 2022: 3). This situation makes the integration of AI competencies into higher education curricula imperative, particularly in the discipline of Public Administration.

In Public Administration, there is an undeniable shift toward administering public services online, employing alternative service delivery mechanisms, such as crowd-sourcing, e-government, virtual and augmented reality, chatbots, and AI-driven customer support (Erasmus, 2021: 18201; Al-Besher & Kumar, 2022: 1-2). To address this shift, governments across the globe are investing heavily in AI laboratories, exploring the possibility of replacing human decision-making as public service AI applications evolve (Mergel, 2023: 1-2). The trend has already heightened citizens' expectations regarding how governments engage with their citizens and deliver services, for example, by adopting Information and Communication Technology (ICT) solutions in government to improve citizen's well-being.

A number of studies have focused on AI in the public sector and its related benefits, risks and implementation (Agarwal, 2018; Barth et al., 1999; Madan and Ahock, 2022; Mergel et al., 2023; Van Noordt et al., 2023; Wirtz et al., 2021). However, despite the consensus around AI's relevance in the public sector, there is a dearth of data on whether existing Public Administration curricula in South Africa are in fact adequately equipped with the competencies required to support AI transformation in the public sector, and to teach those competencies.

Kausch-Zongo and Schenk (2022: 56) assert that the digital transformation of public administration necessitates the development of those competencies that play a pivotal role in preparing future civil servants for the modernisation of administration. Subfields of AI, such as data mining and machine learning, offer the potential to enhance public services, addressing issues in traffic management, education, public health, and safety (Androutsopoulou et al., 2019: 360). This underscores the increasing need for AI competencies to be integrated into diverse academic fields, extending beyond the traditional domains of Science, Technology, Engineering, and Mathematics (STEM) (Laupichler et al., 2022: 1).

In addition, in light of the observation that 82% of middle-skill jobs already require digital skills, it is evident that these skills are fundamental for career advancement and specialised roles (UNESCO & UNESCO-UNEVOC, 2021: 15). However, the incorporation of these essential digital skills into South African Public Administration curricula remains unexplored, calling for critical inquiry. Hence, to address this research gap, this research examines the inclusion of AI competencies in the Bachelor of Administration (BAdmin) curriculum across various South African Higher Education Institutions (HEIs). To achieve the above goal, we adopted the University of Concordia and Dawson's Collage AI competency framework, which focuses on three domains of AI competence: the technical, business, and human domains. This framework highlights the core competencies that AI practitioners need in these three domains. This competency framework is a valuable tool that lecturers and programme coordinators can use to incorporate the development of AI competencies into curricula, as the framework can be used to identify gaps in relation to the development of AI competencies in course offerings and course objectives. The framework does not seek to define the competencies needed in a specific AI role, but rather breaks down the common competencies required for AI practitioners to be proficient (Concordia University and Dawson College, 2021).

This research applies this framework by focusing on two distinct domains, namely technical and human competencies, to assess the current Public Administration curricula in selected South African universities. In doing so, this research contributes to the ongoing global discourse on the imperative to include digital skills in Public Administration curricula, in line with the demands of the current 4IR.

Literature review

Defining artificial intelligence

The term "Artificial Intelligence" or "AI" was initially coined by computer scientist John McCarthy, who described it as "the science and engineering of making intelligent machines" with the capability of understanding "human intelligence" (McCarthy, 2007: 2). McCarthy's (2007) article merely sought to offer basic answers relating to what AI is, but the concept has since evolved to encompass the growing complexity of AI and its application in various aspects of society. This complexity is evident from the lack of consensus in modern literature regarding a single definition for AI, although there is agreement that it involves the development of computer software that can demonstrate "intelligent conduct" comparable to that of human beings (Kaplan, 2016: 1–2; Uzun et al., 2022: 433; Wang, 2019: 1). Artificial intelligence (AI) is the ability of a machine or computer system to perform tasks that typically

require human intelligence, such as logical reasoning, learning, and problem-solving (Morand´ın-Ahuerma, 2022). It is based on using machine learning algorithms and technologies to give machines the ability to apply certain cognitive abilities and perform tasks autonomously or semi-autonomously (Morand´ın-Ahuerma, 2022).

To support the argument that the definition of AI is contested, Kaplan (2016: 1) states that defining AI is "an easy question to ask but a difficult one to answer", given the lack of agreement on how the concept of "intelligence" is understood and the scarcity of scientific evidence validating the relationship between "machine intelligence" and human intelligence.

According to Melanie Mitchell, AI is a branch of computer science that focuses on developing machines capable of carrying out tasks that ordinarily call for human intelligence. These responsibilities include problem-solving, pattern-spotting, language comprehension, and decision-making (Mitchell, 2019: 95). Furthermore, Mitchell links intelligence to common sense (2019: 248), which she claims is "governed" by abstraction, analogy, and the subconscious (2019: 249), language (2019: 95), and understanding, which she additionally refers to as a semantic placeholder and an "ill-defined" term because "we don't yet have the correct language or theory to talk about what's actually going on in the brain." as well as consciousness (2019:255).

In his book "Human Compatible: Artificial Intelligence and the Problem of Control," Stuart Russell describes artificial intelligence (AI) as the branch of computer science that focuses on building robots that can carry out tasks that generally require human intelligence (Russell, 2019: 13). This includes a variety of tasks like problem-solving, identifying things in pictures, comprehending spoken language, and making judgments. In addition, Russell describes three phases of artificial intelligence: artificial general intelligence (AGI), artificial super intelligence (ASI), and artificial narrow intelligence (ANI).In the first stage, AI machines can perform a singular task at the same level or better than humans. Moving to the second stage, AI machines can reason, solve problems, think in abstractions, and make choices as easily as humans can, with equal or better results. Finally, in the third stage, AI involves systems ranging from slightly more capable at performing human cognitive tasks to those that are trillions of times smarter than humans.

Contrary to the above definitions from Russel and Mitchell that include the human aspect of AI, another set of definitions falls under UNESCO's categorisation of AI. Whereby according to UNESCO, a close analysis of the various definitions of AI also reveals that they divide AI into two categories, 'AI techniques' and 'AI technologies' (UNESCO, 2022). The former encompasses the methods used to build different types of AI, while the latter refers to the fields of study and products which are created by those techniques. For example, the Joint Research Centre (JRC) (2020: 14), defines AI as,

> "AI is a generic term that refers to any machine or algorithm that is capable of observing its environment, learning, and based on the knowledge and experience gained, taking intelligent action or proposing decisions. There are many different technologies that fall under this broad AI definition. At the moment, ML4 techniques are the most widely used."

The European AI Strategy (European Commission, 2018:1) defines Artificial Intelligence as "systems that display intelligent behavior by analyzing their environment and taking action to achieve specific goals with some degree of autonomy. This definition notes that AI-based systems can be purely software-based, operating in the virtual world, such as voice assistants, image analysis software, search engines, and speech and face recognition systems. Alternatively, AI can be embedded in hardware devices such as advanced robots, autonomous cars, drones or Internet of Things applications".

Furthermore, the Community survey on ICT usage and e-commerce in enterprises 2021 explains that Artificial Intelligence refers to "systems that use technologies such as text mining, computer vision, speech recognition, natural language generation, machine learning, and deep learning to gather and/or use data to predict, recommend, or decide the best action to achieve specific goals, with varying levels of autonomy" (European Commission 2023).

In view of the lack of consensus on how to define AI, for the purposes of this research AI is defined as the digital simulation of human processes through the use of algorithms and models that enable machines to perform tasks that typically require cognitive functions such as comprehension, reasoning and problem-solving (European Commission, 2018:121; Zuiderwijk, 2021:2; Siemens et al., 2022: 1–3). Overall, it can be inferred that AI systems are employed for data analysis, pattern identification, trend forecasting and rational decision-making duties that would traditionally be performed by a human being, thereby mimicking human intelligence artificially.

Artificial intelligence competencies

The importance of digital skills is increasing exponentially as the world continues to make technological advances and adopt 4IR trends. Notably, the 4IR has created a need for education systems to promote AI competencies that equip students for future work. Although there is no universal definition of the term "competency" (Wong, 2020: 98), the various definitions cited by Wong (2020) suggest that the concept encompasses the set of skills, knowledge, attitudes, and behaviours that are required to be proficient in a particular job or activity. Mikalef et al. (2023: 3) define AI competence as "a core competency of organisations that highlights the need for creative and harmonious deployment of AI". These authors argue that in order to coordinate the use of AI effectively in organisations, individuals must possess the technical ability to use it, the versatility to handle its diverse processes and procedures, and the initiative continuously to test new methods and ways of operating to avoid replication by competitors and gain a competitive edge (Mikalef et al., 2023).

Sanusi et al., (2022a: 3) use a framework for AI competencies in education developed by Sanusi et al., (2022b: 2-3) to establish a research model that illustrates "the role of learners' competencies in artificial intelligence education". The model divides the key competencies of learners in the context of AI education into three categories: knowledge, learning, and team competencies. Each of these categories has sub-competencies that are instrumental in achieving AI competence.

The knowledge competencies in curricula are essential since they inform students of new AI concepts and applications and comprise "skill and cultural competencies" as the sub-competencies under that category (Sanusi et al., 2022a: 2–4). These sub-competencies allow learners to put the knowledge and skills they have attained to practical use in various scenarios while accounting for their AI usage's social and ethical implications (Sanusi et al., 2022b: 2–4).

Team competencies aid collaborative efforts that are enhanced through teamwork and human-tool collaboration (Sanusi et al., 2022a: 2-4). Sanusi et al., (2022b: 8) found that "human-tool collaboration" is the most critical competency required for AI literacy, because of the tendency for human talent to be effectively cultivated and used when collaboration between humans and machines is managed correctly. It promotes responsible behaviour, cultivates a better working experience and maximises technological investment (Cantrell et al., 2022). Furthermore, Sanusi et al., (2022a: 4) cite a study by Rosen and Tager (2013), which found that "human-to-agent" problem-solving tends to be more rigorous than human-to-human collaboration, showing the importance of this sub-competency. Lastly, these learning competencies are essential for continual learning and adaptation – Sanusi et al.

(2022b) explain that cognitive competence and self-learning competence allow learners to understand and apply AI concepts coherently and to embrace the need progressively to seek more knowledge.

In a study titled "Training Tomorrow's Intelligence-Amplified Policy Analyst: A Public Administration Curriculum for the Digital Era", Sadaf (2020) conducted interviews with leaders in the Canadian public service to find out which skills public servants need to obtain in order to be future fit. The recurring themes in that study were the importance of data analytics, knowledge of technology functions, collaboration, ethics, and professional exposure.

These themes are similar to the competencies proposed in the "UF AI Literacy model" developed by Southworth et al. (2023: 5-7), which identifies five categories of AI literacy in curricula. The first competency is "Enabling AI", which emphasises developing a foundational knowledge base and skillset needed to operate AI (Southworth et al., 2023: 5). This requires understanding the main aspects of AI and how to operate various AI applications, depending on the context. The second competency, "Know & Understand AI", developing a deep understanding of AI further (Southworth et al., 2023: 6). This requires a student to know the technical principles and algorithms that are integrated into the system. The next competency, "Use & Apply AI", focuses on skills development, equipping students with the ability to choose and appropriately apply AI resources tailored to a specific application (Southworth et al., 2023: 6). Next, the ability to "Evaluate and Create AI" focuses on the critical thinking skills needed to evaluate AI functionality critically, along with the ability to design new solutions that are responsive to service needs (Southworth et al., 2023: 6). Lastly, "AI Ethics" is about being able to account for the ethical considerations related to AI by knowing how to use AI in a manner that is ethical, legal, and conscientious (Southworth et al., 2023: 6). Overall, the UF model provides a substantive framework for integrating AI competencies across the curriculum. This can help guide understanding of AI competencies in the current research article.

Emanating from the above, it is clear that, when it comes to AI competencies, there are various frameworks and competencies. For the purposes of this article, to measure the AI competencies in the BAdmin curriculum, this research used the AI competency framework developed by Concordia University and Dawson College (2021).

Methodology

This research employed a qualitative approach. Qualitative research entails systematic data generation, analysis, and interpretation to address specific research inquiries (Masiya and Lubinga, 2023). A qualitative approach was the most applicable in this research since it provides a holistic insight into phenomena that cannot be fully articulated by numbers (Tilley, 2019:160-161). This research study uses a case study design. Crowe et al. (2011: 1) state that a case study applies a particular case to better understand an issue or phenomenon. A case study design fits into this research because it enables us to gain more insight into the integration of AI Competencies into the BAdmin curriculum. Data for this research was sourced from authoritative sources consisting of published documents that offer insight into the Public Administration curricula of various HEIs, such as journal articles, institutional websites and official BAdmin curricula documents. Out of the 26 South African HEIs, only six currently offer an undergraduate BAdmin degree. Out of the six institutions, three were randomly selected, namely: the University of Pretoria, the University of South Africa and the University of the Western Cape and their curricula were analysed. The curricula and all sources were selected considering the four principles of trustworthiness in qualitative research: credibility, transferability, dependability, and confirmability (Lincoln and Guba, 1985).

Once the sources were identified and properly organised, a critical reading process was undertaken to assess the integration of AI competencies in undergraduate Public Administration curricula in the selected South African HEIs. Thematic analysis was used to analyse the data in this research. According to Maguire and Delahunt (2017), thematic analysis is a method of discovering patterns or themes in qualitative data. The goal of thematic analysis is to identify themes or patterns in data and then use them to address the research problem. This research employed the deductive method of thematic analysis using a predefined set of codes emanating from the literature on AI competencies, namely technical and human, excluding the business domain.

The decision to focus solely on the technical and human domains while omitting the business domain in this study was based on the fact that the two domains provided sufficient depth and breadth for their study with the available sources, time constraints, and research objectives. Additionally, the technical and human domains were more directly relevant to the field of Public Administration, particularly in the context of AI integration. Technical competencies relate to understanding AI systems and their implementation, while human competencies involve the skills needed to interact with AI technologies effectively. ATLAS. ti software was used, as in a similar study by Lubinga et al. (2023), who studied the challenges of adopting 4IR in South African HEIs. The AI software was used to identify repeated patterns, helping the researchers to formulate codes that guided this analysis of AI competencies in the sampled BAdmin curricula.

Findings

This research assessed the integration of AI competencies in undergraduate Public Administration curricula in the selected South African HEIs. The study used the AI competency framework developed by Concordia University and Dawson College (2021), which was mentioned earlier, to achieve this goal. The study examined two of these three domains since the sub-competencies selected relate to the discipline of Public Administration, namely technical and human competencies. The sub-competencies selected to analyse the technical competencies were data analytics, mathematics, and statistics; the

sub-competency selected to analyse the human competencies was innovation. Based on a thorough inspection of the curricula of the three institutions, this section presents a tabulated summary of the modules offered in the three selected institutions' BAdmin programmes, presented under the "Human competency" and "Technical competency" categories in Table 1, followed by an analysis of the data in the table. A discussion of the findings follows this section.

Table 1. Technical and human AI competency integration in the undergraduate BAdmin curricula of South African HEIs.

HEI sHEI	Curriculum summary	Year	Module type	Technical competencies		Human competencies
				Data analytics	Mathematics & Statistics	Innovation
Institution A (University of South Africa)	The curriculum is split into three years. The core modules generally cover content relating to the fundamentals of Public Administration, while the elective modules address economics, finance, human resource management (HRM), law, statistics, and welfare in the public sector.	Year 1	Core	N/A	N/A	N/A
			Electives	Accounting Information Systems	Descriptive Statistics and Probability	End-User Computing
				Quantitative Modelling	Statistical Inference	N/A
				Ethical use of ICTs	Quantitative Modelling	N/A
		Year 2	Core	N/A	N/A	N/A
			Electives	N/A	Linear Mathematical Programming	N/A
				N/A	Nonlinear Mathematical Programming	N/A
		Year 3	Core	N/A	N/A	N/A
			Electives	N/A	Mathematical Modelling	Technology & Innovation
Institution B (University of Pretoria)	This programme provides in-depth knowledge of the various functions and management practices in the South African public service. The core modules focus on politics, international relations, HRM, public financial management	Year 1	Core	Academic Information Management I	N/A	N/A
				Academic Information Management II	N/A	N/A
			Electives	Informatics	Statistics I	N/A
		Year 2	Core	N/A	N/A	N/A
			Electives	N/A	Statistics II	N/A
		Year 3	Core	N/A	N/A	N/A
	(PFM), public policy and law, and inter-governmental relations (IGR).		Electives	N/A	N/A	N/A
Institution C (University of Western Cape)	This curriculum aims to educate students on content relating to both Economics and Management Sciences (EMS) and social sciences by addressing a diverse range of topics – from politics and public policy to economics and financial management.	Year 1	Core	N/A	Quantitative Literacy for Commerce	Information Systems
			Electives	Business Statistics	Business Statistics	N/A
				Statistics	Statistics	N/A
		Year 2	Core	N/A	N/A	N/A
			Electives	Business Analysis	N/A	N/A
				Systems Delivery Management	N/A	N/A
		Year 3	Core	N/A	N/A	N/A
			Electives	N/A	N/A	Information Systems
				Information Systems	N/A	Information Systems

■ Year 1 modules (NQF level 5) ■ Year 2 modules (NQF level 6) ■ Year 3 modules (NQF level 7)

Technical competencies

The findings from the University of South Africa, the University of Pretoria and the University of Western Cape, relating to the extent of their incorporation of the requisite AI Technical competencies in their BAdmin programmes, are discussed below. As mentioned earlier, to assess the technical competency domain, the researchers used two subcategories from the AI competency framework, data analytics, mathematics and statistics, to identify the extent to which the technical competencies are incorporated in the various BAdmin programmes.

Based on the findings in the table above, one can assert that none of the three institutions offer key Public Administration core modules in their curricula that fully support the technical competencies domain, such as mathematics, statistics, or data analytics. Core modules are defined as mandatory modules in an academic programme. Instead, across the three selected institutions, data analysis

aspects occur in the introductory ICT modules only in the University of South Africa. In the other two institutions, these modules are electives.

The University of Pretoria offers two core modules that support the technical domain to some extent, specifically the data analysis sub-competency. That is Academic Information Management (AIM) across two semesters in the programme's first year. These modules focus on the basics of ICT, examining the various web and application software types needed to manage academic information resources effectively. The second-semester version of AIM focuses on developing the ability to employ effective search strategies while using different technological applications and tools ethically (University of Pretoria 2024, 31). In addition to the two AIM modules, the University of Pretoria offers elective modules, notably Informatics and Statistics, at the first-year and second-year levels. The University of Western Cape includes two core modules in the first year of study that address the sub-competency of data analytics. The first of these modules is Quantitative Literacy for Commerce and Information Systems at the University. The module promotes data analytics by teaching students how to analyse and interpret models and diagrams and equipping them to organise and arrange logical data structures (University of the Western Cape, 2021: 21–25). The module also builds student knowledge of the software development lifecycle to demonstrate an understanding of information systems trends for analysis. This module teaches students the foundations of database design, data modelling, and the latest information technology (IT) trends. Similarly, the Systems Delivery Management module educates students on various information systems theories, methodologies, and frameworks by requiring students to complete a project that applies this knowledge using IT software tools. This is supported by the Business Statistics and Statistics modules, in which students are required to use a computer to conduct data analysis.

With regard to the other subcategories in the technical competency domain, Mathematics and Statistics, all the modules offered across the three selected institutions' Public Administration programmes are elective modules. An example is that the University of South Africa offers the Accounting Information Systems module, which seeks to educate students on the theoretical components of information systems and technological infrastructure. It does not explicitly cover data analytics, but accounting information systems tend to incorporate data analytics since professionals use these information systems to analyse data critically to identify trends and make forecasts (Jafar et al., 2017: 23). With a similar effect, the module on Quantitative Modelling offered at the University of South Africa additionally aims to build the mathematical foundations and computational skills needed in a corporate setting. The module implicitly encompasses data analytics since quantitative modelling involves the organisation and interpretation of data sets to predict future trends.

A third module at the University of South Africa attempts to promote data analytics, and this module deals with the ethical use of ICTs for Development Solutions by educating students on intellectual property law, privacy, ethical conduct and various other social dimensions. It thus builds the skills needed to critically inspect data by educating students on the need to be diligent and aware of the ethical implications of working in an information-driven society. Regarding the mathematics and statistics sub-competency, the institution offers three elective modules at a first-year level, two at a second-year level and one in the final year. In the first year, the Descriptive Statistics and Probability module offers students an opportunity to gain a baseline level of understanding of statistics; this module is complemented by the Statistical Inference module, in which various statistical methods are explained and applied, and students must interpret and graphically present statistical information. Probability is also a key element here, as it is used to forecast trends and associations.

Quantitative Modelling, as mentioned earlier, aims to build mathematical foundations and computational skills. Thus, it complements the other two statistical modules at the University of South

Africa Institution Awell. During the second year, students may take two modules on linear mathematical programming and Nonlinear Mathematical Programming, respectively. During the final year of study, the institution offers Mathematical Modelling as an elective module to help students forecast economic and financial phenomena.

The University of Pretoria offers elective modules, notably Informatics and Statistics. Both modules are offered at a first-year and second-year level. The first-year Statistics module can be completed in the first semester of the first year or across the whole year (divided into two modules). Overall, it covers basic descriptive statistics and probability. The second-year Statistics module covers similar content but delves deeper into inferential statistics, algebra, and economics themes. The skills of being able to sample, collect, and analyse data are immensely valuable in interacting with AI tools, so there is a great need to cultivate them.

Similarly, the University of Western Cape offers elective modules that support the mathematics and statistics sub-competency, such as the Systems Delivery Management module, which educates students on various information systems theories, methodologies, and frameworks by requiring students to complete a project that applies this knowledge with the use of IT Software tools. This is helped by the Business Statistics and Statistics modules, in which students are required to use a computer to conduct data analysis.

The Business Statistics and Statistics modules at the University of the Western Institution C also include Mathematical and Statistical competencies that are valuable to the private and public sectors. Descriptive statistics, probability, and inferential statistics are taught according to the curriculum of both classes. The other module that promotes this sub-competency is Quantitative Literacy for Commerce. This module deals with economic calculations and the statistical measures for dispersion and central tendency. Most of these modules at the University of the Western Cape are offered in the first year as in the other institutions.

Human competencies

As previously mentioned, Human competencies can be divided into two sub-competencies, namely Innovation and Teamwork. Still, for this research, the focus was only on innovation, where we assessed modules in the curriculum pertaining to innovation across the three institutions.

Innovation is vital in artificial intelligence, but it is clear that none of the three institutions offer innovation-related core modules in their Public Administration curricula. Of the three selected institutions, only the University of South Africa and the University of Western Cape offer elective modules that may link to the innovation aspect somehow.

The University of South Africa has two modules related to the need to be digitally innovative. The first is the End-User computing module, offered in the first year of study. It educates students on the various applications of IT in their lives. This is arguably an appropriate starting point since a foundational understanding of an information system's basic hardware and software can equip students with the knowledge and skills to interact innovatively with such systems. Thereafter, the third-year module on technology and innovation seeks to teach the skills students need to gain a sustainable competitive edge in the marketplace. This means that in this curriculum, only one module explicitly seeks to foster innovative thinking in its outcomes, while this outcome can be inferred in the other module.

Human competencies are not heavily promoted in the University of Pretoria's curriculum. The first notable omission is that no modules in this curriculum build on an individual's innovative capacity.

The University of Western Cape, unlike the University of Pretoria, presents one elective module, the information systems module, in the first and third years, which develops AI human competency by informing BAdmin students about the role of information systems in public organisations and how technology affects their functions. These modules allow students to identify and delineate diverse information systems and their concepts while informing students of the different telecommunications and computer networks. All three Information Systems modules teach students how to leverage information systems in a global environment to gain a competitive advantage, and innovation is fostered. The Information Systems module in their final year teaches students how to apply information systems to create value and inspire innovation.

Discussion

The study findings suggest that the Public Administration curriculum of the South African HEIs that were reviewed does not adequately prioritise AI competencies. None of the three universities analysed provide comprehensive core modules that fully address the two fundamental AI competencies, namely technical and human competencies, across the 3-year curriculum. Specifically, this research discovered that only the University of South Africa included data analysis features in the introductory ICT modules, based on the findings related to the technical domain, particularly the sub-competency of data analysis, among the three selected universities. In the other two universities, the modules pertaining to the sub-competency of data analysis are only offered as elective modules.

In addition to the above, concerning the other sub-categories, mathematics and statistics, all the modules offered across the three selected institutions' Public Administration programmes are elective modules under the technical competency domain. Moreover, in the realm of human affairs, while examining innovation as a sub-competency, none of the three schools include fundamental modules linked to innovation in their Public Administration curricula. These findings concur with those of Kausch-Zongo and Schenk (2022), who found a general technological competency and usage gap in public administration education. Furthermore, the findings raise concerns about the South African BAdmin curricula and whether they support the much sought-after digitalised public sector. This poses broader implications for the South African landscape of teaching public administration, where graduates will not have AI competency, thereby hindering the public sector's ability to leverage technology effectively to improve efficiency, service delivery, and innovation. As AI becomes increasingly integrated into government operations, public administrators need the knowledge and skills to harness its potential for enhancing governance and decision-making processes (Mikalef et al., 2019). Similarly, Campion et al. (2020) argue that using AI in public sector activities can significantly benefit governmental duties by providing services that citizens cannot achieve independently.

Furthermore, as shown in Table 1, none of the core courses in the selected institutions cover mathematics, statistics or innovation. If included in the BAdmin program, they are only offered as elective courses. This implies students have the choice not to opt for these modules. The corollary is that some students lack exposure to any of these competencies throughout their undergraduate years of study, as students tend to opt for modules that they are comfortable or familiar with instead of stepping out of their comfort zone. This often leads to unbalanced skills development, as most students do not acquire these key competencies. This same finding is witnessed in a study by Xu and Babaian (2021), whose examination of the top 25 U.S. business schools showed that although many business programs offered data mining and analytics courses. These courses often focused only on introducing statistics and machine learning techniques related to data analysis. They did not adequately prepare students for future work environments where a broad array of diverse AI technologies is used.

So, emanating from the above, it can be deduced that although Artificial intelligence is rapidly reshaping the technological landscape, it is becoming an important component of work processes and decision-making in many domains. AI integration into education has yet to catch up with the challenge of introducing this complex and very important area of technology to audiences beyond the students of computing and engineering disciplines. This poses several pedagogical and practical implications that need to be addressed. Firstly, the core modules of the Public Administration curriculum need to be comprehensively reviewed and revised to address both technical and human competencies related to AI. The program should cover essential aspects such as data analysis, mathematics, statistics, and innovation. These are necessary to ensure that students acquire foundational knowledge and skills in AI. Secondly, the three institutions should re-evaluate their AI-related elective modules and make them core curriculum components. This will ensure that all students receive adequate exposure to AI competencies. Thirdly, since AI is interdisciplinary, departments and faculties must collaborate to design and deliver comprehensive AI education. Public Administration programs should partner with departments specialising in computer science, mathematics, and engineering to ensure a holistic approach to AI education.

Additionally, based on the argument that individuals in higher education must gain a basic understanding of AI to interact effectively with the technology in their future work (Laupichler et al., 2022: 1), the findings indicate that it is important that HEIs revise their curricula to include AI competencies to prepare students adequately to address the challenges and leverage the opportunities presented by society's changing nature.

Furthermore, AI has the potential to greatly influence the future if it is incorporated into public policy-making and service-delivery processes (Berryhill et al., 2019: 72-87). Reis et al. (2019: 4) also assert that AI-driven mechanisms such as decision support systems (DSS) enrich decision-making in the public service. The current study proposes that BAdmin curricula teach the theoretical and practical application of AI-driven mechanisms such as DSS in the curriculum. This knowledge could come from studying the literature on how such AI tools are used and how they enhance public service.

In addition, being ready for the future requires BAdmin students to possess AI competencies, to allow them to derive some of the operational benefits of using e-governance systems (Erasmus, 2021: 18203). Since e-governance systems can inform public decision-making by analysing big data and identifying trends (Erasmus, 2021: 18203), the study suggests the inclusion of practical assignments that require students to use a simulation form of DSS software or other AI tools to sort and organise large quantities of data. The study believes that including this in BAdmin curricula across South Africa will finally improve the effectiveness of teaching students' key competencies such as data analytics, which falls under broader technical AI competencies.

Van Dijk and Thornhill (2011: 17) place the responsibility on scholars to ensure that the cognitive skills necessary to solve societal issues are ingrained in Public Administration curricula. This is evidently not happening to the maximum extent. In this regard, Berryhill et al. (2019: 26) point out that governments' adoption of AI "trails" behind that of the private sector. South Africa's top HEIs have embraced the 4IR, but the majority of HEIs have fallen behind (Lubinga et al., 2023: 3). The study believes that promoting AI competence in the study of Public Administration is imperative for South Africa to keep up with the 4IR and its transformational effects. Training must keep up with the fact that AI is expected to transform public service delivery by automating certain functions, requiring public servants to be "re-trained and re-employed" (Reis et al., 2019: 5).

The study further argues that there needs to be a change to the undergraduate Public Administration curricula in South Africa. The curriculum should focus on practical applications of the digital tools that

public employees and civil servants are or should be using to make their functions more efficient. This should be done in a way that equips public servants with the necessary human-tool collaboration skills explained by Sanusi et al. (2022b), which then reframes the view of AI, changing it from a threat to employment to a job resource (Mckinsey Global Institute, 2017: 31). Public Administration curricula should reflect how the government can leverage these technologies to improve service delivery and combat inefficient governance practices (Erasmus, 2021: 18199).

The study also recommends that HEIs create initiatives that can drive this change. Before curricula can advance, the people creating them must be upskilled. This research recommends using faculty development programmes that help lecturers to remain updated and "future fit". This kind of training can take the form of regular workshops and training programmes aimed at refreshing staff on AI concepts, tools, and applications. The South African Artificial Intelligence Association (SAAIA) has an ongoing initiative that relates to integrating these AI competencies into Public Administration curricula in South Africa, since its mission is to promote responsible and responsive AI adoption to remedy the nation's socio-economic conditions (SAAIA, 2023a). The association has committed itself to uniting practitioners across numerous sectors, including the government and education sectors, and has partnered with HEIs. There is strong potential for Public Administration curricula to take on board initiatives that foster competitive and inclusive AI-driven governance.

Conclusion

This research assessed the integration of AI competencies in the undergraduate BAdmin curricula of three randomly selected HEIs out of six that offer such a programme. The qualitative research approach focused on two selected competencies: human and technical. The findings revealed that AI competencies are not adequately integrated into the public administration curricula of the assessed HEIs because none of these three HEIs offer core modules in their public administration curricula to support AI competencies. Instead, AI competencies are relegated to elective (optional) modules. This reveals a general AI competency gap in the public administration curriculum of the assessed HEIs in South Africa. The study recommends that HEIs revise their curricula to include AI competencies that will prepare students adequately to address the challenges and leverage the opportunities presented by this rapidly changing aspect of society.

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