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A Model for Applying Artificial Intelligence in Egyptian Universities

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Abstract:

This research presents a comprehensive model for the application of artificial intelligence in Egyptian universities with the aim of enhancing academic and administrative performance. The study highlights the main applications of artificial intelligence, including predictive analytics of student performance, smart resource management, automated communication systems, and the integration of artificial intelligence technologies into curriculum design and institutional decision-making processes. These applications are expected to address contemporary challenges in the higher education sector, such as increasing student engagement, streamlining processes, and enhancing innovation.

The research relied on a descriptive analytical methodology to assess the current status of artificial intelligence adoption in Egyptian universities. The dimensions of artificial intelligence considered in this study included machine learning, natural language processing, computer vision, and robotics. To validate the proposed model, advanced statistical techniques, such as AMOS, were used to measure the correlations between these dimensions and their impact on Egyptian universities.

The results confirmed the existence of significant correlations, indicating that the adoption of artificial intelligence can significantly improve operational efficiency, innovation, and strategic decision-making. The study concludes by developing a final model that provides actionable insights and a practical framework for the application of artificial intelligence in universities. This model is designed to be a sustainable tool that Egyptian universities can rely on to achieve long-term goals in education, management, and research.

The research recommends upgrading digital infrastructure, implementing comprehensive AI training programs for employees, and developing clear policies that encourage the integration of AI technologies into all university functions. These findings not only provide solutions to current challenges, but also lay the foundation for future progress in AI-based education systems.

Keywords: Artificial Intelligence, Egyptian Universities, Competitive Advantage, Machine Learning, Natural Language Processing, Computer Vision, Robotics.

الملخص:

يقدم هذا البحث نموذجًا شاملاً لتطبيق الذكاء الاصطناعي في الجامعات المصرية بهدف تعزيز الأداء الأكاديمي والإداري. وتسلط الدراسة الضوء على تطبيقات الذكاء الاصطناعي الرئيسية، بما في ذلك التحليلات التنبؤية لأداء الطلاب، وإدارة الموارد الذكية، وأنظمة الاتصالات الآلية، ودمج تقنيات الذكاء الاصطناعي في تصميم المناهج وعمليات صنع القرار المؤسسي. ومن المتوقع أن تعالج هذه التطبيقات التحديات المعاصرة في قطاع التعليم العالي، مثل زيادة مشاركة الطلاب، وتبسيط العمليات، وتعزيز الابتكار.

اعتمد البحث على منهجية تحليلية وصفية لتقييم الحالة الحالية لتبني الذكاء الاصطناعي في الجامعات المصرية. وشملت أبعاد الذكاء الاصطناعي التي تم النظر فيها في هذه الدراسة التعلم الآلي، ومعالجة اللغة الطبيعية، والرؤية الحاسوبية، والروبوتات. للتحقق من صحة النموذج المقترح، تم استخدام تقنيات إحصائية متقدمة، مثل برنامجAMOS ، لقياس الارتباطات بين هذه الأبعاد وتأثيرها على الجامعات المصرية.

وأكدت النتائج وجود ارتباطات مهمة، مما يدل على أن تبني الذكاء الاصطناعي يمكن أن يحسن بشكل كبير من الكفاءة التشغيلية والابتكار واتخاذ القرارات الاستراتيجية. وتختتم الدراسة بتطوير نموذج نهائي يوفر رؤى قابلة للتنفيذ وإطار عملي لتطبيق الذكاء الاصطناعي في الجامعات. تم تصميم هذا النموذج ليكون أداة مستدامة يمكن للجامعات المصرية الاعتماد عليها لتحقيق أهداف طويلة الأجل في التعليم والإدارة والبحث.

يوصي البحث بتحديث البنية التحتية الرقمية وتنفيذ برامج تدريب شاملة على الذكاء الاصطناعي للموظفين ووضع سياسات واضحة تشجع على دمج تقنيات الذكاء الاصطناعي في جميع وظائف الجامعة. لا تقدم هذه النتائج حلولاً للتحديات الحالية فحسب، بل تضع الأساس أيضًا للتقدم المستقبلي في أنظمة التعليم التي تعتمد على الذكاء الاصطناعي.

الكلمات المفتاحية:

الذكاء الاصطناعي، الجامعات المصرية، ، التعلم الآلي، معالجة اللغة الطبيعية، الرؤية الحاسوبية، الروبوتات.

Introduction:

In the context of rapid transformation towards a digital economy and the increasing challenges facing higher education, universities are required to adopt modern technologies to achieve a sustainable competitive advantage. In this regard, Fourth Generation Universities have emerged as an evolutionary model aimed at integrating technology and innovation to enhance institutional capacity and improve student affairs services (Etzkowitz, & Leydesdorff, 2000). These universities emphasize aligning educational strategies with the demands of the knowledge economy, embedding digital transformation to foster adaptability and global competitiveness. (UNESCO, 2022)

The success of Fourth Generation Universities relies heavily on a robust technological infrastructure that optimizes the utilization of advanced solutions. This includes high-speed internet networks covering all campus areas, classrooms equipped with smart laboratories, interactive screens, and sensors that enhance interactive learning. Furthermore, cloud computing systems enable efficient data storage and management, providing seamless integration of digital tools (Dastbaz, et al., 2018).

Blended learning, a cornerstone of Fourth Generation Universities, integrates traditional face-to-face instruction with digital platforms, enabling a flexible and interactive learning environment. This model relies on Learning Management Systems (LMS) like Moodle and Canvas, which support student-centered approaches and personalized education. Additionally, the incorporation of virtual reality (VR) and augmented reality (AR) creates immersive learning experiences that align with diverse student needs and learning styles (Means, et al., 2014).

The role of Artificial Intelligence (AI) in modern education is transformative, with applications ranging from predictive analytics for student performance to chatbots that provide instant responses to inquiries. These systems not only enhance academic outcomes but also facilitate better decision-making for administrative and academic staff. By analyzing student data, universities can identify at-risk students early and implement targeted interventions to improve retention and success rates (Shapiro, 2021).

Efficient campus facility management is another defining characteristic of Fourth Generation Universities. Through smart energy management systems and Internet of Things (IoT) devices, universities monitor environmental conditions such as lighting and temperature, ensuring sustainability and cost-efficiency. Green building designs further support energy conservation efforts, reflecting the commitment of these universities to environmental responsibility (Gamage, et al., 2022).

In terms of student services, universities employ smart applications to simplify processes such as registration, fee payments, and schedule access. Enhanced services, including telemedicine within the campus and smart parking systems, provide a seamless and student-friendly environment. These innovations demonstrate the role of technology in creating supportive and efficient educational ecosystems (Hrastinski, 2019).

Furthermore, scientific research and innovation are integral to the advancement of Fourth Generation Universities. Equipped with cutting-edge laboratories, these institutions leverage AI tools to analyze research data, accelerate discoveries, and foster interdisciplinary collaborations. Partnerships with industry leaders in technology drive applied innovation and enhance the university's academic standing (García-Peñalvo, & Seoane, 2020).

In Egypt, private universities face increasing challenges in a competitive educational market, necessitating innovative strategies that leverage AI technologies to enhance institutional capacity and improve the quality of academic and administrative services. This research aims to propose a framework for implementing AI technologies in Egyptian private universities, focusing on their impact on student affairs and raising institutional performance levels in alignment with smart university standards and the evolving demands of higher education in the 21st century (Ahmed, & Fathy, 2023).

1/1- Problem Statement

In the rapidly evolving landscape of higher education, Egyptian universities face increasing challenges in maintaining competitiveness and aligning with global standards. The emergence of Fourth Generation Universities (4GUs) underscores the critical need to integrate advanced technologies, such as Artificial Intelligence (AI), to enhance academic, administrative, and research capabilities.

To define the study's problem, personal interviews were conducted as a data collection tool with a survey sample of 40 faculty members from private universities in Egypt. These interviews aimed to assess the current status of AI application in Egyptian universities. The interviews included eight main questions to determine the extent to which AI is being employed in this context. The interview results yielded the opinions shown in the following table:

Table 1: Results of the Opinions on AI Implementation Dimensions

Opinion Poll Phrases	Agree (%)	Neutral (%)	Disagree (%)
AI is utilized to improve student academic performance prediction systems.	60	20	20
Universities use AI to support innovation in academic and research services.	55	25	20
Commitment to AI-driven solutions in administrative processes is evident.	50	30	20
AI is integrated into student support and interaction systems.	50	25	25
Universities emphasize training faculty and staff on AI applications.	45	35	20

Source: Prepared by the researcher based on the universities under study and application

- Academic Performance Prediction: A majority (60%) agree that AI systems enhance academic predictions, reflecting strong adoption in this area.
- Innovation in Services: Over half (55%) agree that AI supports innovation in academic and research services, yet 20% disagree, showing variability in effectiveness.

- Administrative Processes: Half (50%) of respondents agree on AI’s role in administrative enhancements, with 30% neutral, highlighting this as a growth area.
- Student Support: While 50% agree on AI's integration into student support, a quarter (25%) disagree, indicating inconsistent application.
- Faculty Training: Only 45% agree on faculty and staff training in AI, with 35% neutral, identifying this as a priority for further development.

Fourth Generation Universities are characterized by their focus on innovation, digital transformation, and societal impact. They leverage AI to drive operational efficiency, personalize education, foster interdisciplinary research, and contribute to sustainable development goals. However, many Egyptian universities continue to rely on traditional methods, lacking a strategic framework to fully harness AI’s transformative potential.

Key challenges include:

- Insufficient technological infrastructure to support AI-driven applications.
- Inefficient administrative processes that hinder operational efficiency and effective resource utilization.
- A lack of AI-based tools for personalizing student learning experiences and improving academic outcomes.
- Minimal integration of AI in research activities, leading to missed opportunities for innovation and global competitiveness.

This research aims to address these challenges by proposing a comprehensive framework for implementing AI in Egyptian universities. By focusing on the principles and characteristics of Fourth Generation Universities, the study seeks to bridge the gap between current practices and the potential offered by AI. The proposed framework will enable universities to improve educational quality, strengthen their competitive position, and increase their societal contributions in a rapidly digitalizing world.

The problem of the study is represented in answering the following main question:
"How can the application of artificial intelligence enhance the efficiency and effectiveness of private universities in Egypt to address current challenges?"
To address this main question, the following sub-questions were formulated:

1. What is the relationship between the dimensions of artificial intelligence and the performance of private universities in Egypt?
2. What is the impact of applying the dimensions of artificial intelligence (machine learning, natural language processing, computer vision, and robotics) on improving the quality of the educational process in private universities?

1/2- Importance of The Research:

1/2/1- Practical Importance:

- Highlights the role of artificial intelligence (AI) in enhancing the competitive advantage of Egyptian universities.
- Focuses on the application of AI in academic and administrative domains to address rapid changes in the global higher education sector.
- Emphasizes the adoption of Fourth-Generation University models by integrating advanced technologies.
- Proposes a framework for implementing AI in Egyptian universities to align with global advancements.
- Offers practical solutions to enhance operational efficiency, reduce costs, and improve the quality of education.
- Aims to enhance the international reputation of Egyptian universities and their attractiveness to local and international students.

1/2/2-Scientific Importance:

- Enriches the literature on the application of artificial intelligence in higher education, with a specific focus on Egyptian universities and Fourth-Generation Universities.
- Provides insights into utilizing AI technologies to improve academic and administrative performance in Egyptian universities.
- Contributes to enhancing the competitive edge of these universities.
- Opens new avenues for future research, encouraging exploration of modern technologies in higher education institutions.
- Serves as a foundation for further studies on the integration of AI in education systems globally.

1/3- Research Objectives

In the modern era, universities are key drivers of academic and technological advancement, and they are required to adapt to the rapid changes in the education and research environments. With the continuous technological progress, it has become essential for universities to enhance their performance and increase their competitive advantage by integrating innovative solutions such as artificial intelligence (AI). This research aims to study how AI can be applied in Egyptian universities and analyze its impact on improving academic, administrative performance and fostering institutional excellence.

In this context, a set of objectives has been identified that this research seeks to achieve. These objectives aim to provide a comprehensive framework for AI integration, assess the current situation of its applications, explore its role in enhancing the competitive advantage of universities, and offer strategic recommendations to improve its effectiveness in the future. These objectives are as follows:

1. Develop a comprehensive framework for integrating artificial intelligence in Egyptian universities.
2. Evaluate the current situation of AI adoption in Egyptian universities.
3. Investigate the role of artificial intelligence in improving the competitive

advantage of Egyptian universities.

4. Provide recommendations for policies and strategies for implementing AI in Egyptian universities.

1/4- Research Hypothesis

The following hypotheses are formulated to examine the role of artificial intelligence in Egyptian universities. These hypotheses focus on the relationship between the application of AI and its impact on various operational aspects within these universities.

H1: "*The model expressing using Ai in Egyptian universities is significant*."

2- Artificial Intelligence concepts

Artificial intelligence (AI) is a branch of computer science aimed at creating systems capable of performing tasks that typically require human intelligence. These tasks include learning, reasoning, pattern recognition, and problem-solving. AI techniques involve developing algorithms and models that enable machines to learn from data and make decisions based on intelligent analysis (Russell, et al., 2010).

Artificial intelligence (AI) is defined as "an aspect of computer science that seeks to provide a variety of methods, techniques, and tools to create models and solutions to problems by simulating the behavior of individuals" (Ocaña-Fernández, Valenzuela-Fernández, & GarroAburto, 2019, p. 15). This definition highlights AI’s goal of mimicking human behavior to develop computational models and solutions that address complex problems (Ocaña-Fernández,et al., 2019).

Based on the above, the researcher concludes that all definitions that defined artificial intelligence agreed that it is a group of smart and technical technological applications that humans use to perform their tasks and are characterized by high accuracy and flexibility. Therefore, it seeks to facilitate the performance of various tasks in universities and raise their quality in order to achieve the highest levels of efficiency in work.

3- AI Evolution:

Artificial intelligence research dates back to the 1940s, when its idea was proposed at the first conference at Dartmouth College in the United States of America in 1951. This college is considered the accredited academic institution in the origins of artificial intelligence, and since that time this term has been officially adopted by the American computer scientist John McCarthy (Khaled , 2022).

During this period, interest in developing artificial intelligence increased, as several languages were invented, including the LISP programming language, which was also invented by computer scientist John McCarthy (Thaer & Sadiq 2006).

With the emergence and spread of computers, interest in neural networks increased in the early 1950s. The scientist Frank Rosenblatt developed theories of neural networks, whose idea was based on creating a device that resembles the human mind, given that the mind is not just a machine. He created a neural network that mimics the human mind, and it was the first neural network in history (George, 2009).

Then the period from the mid-sixties of the twentieth century to the seventies was characterized by the discovery of methods for representing knowledge and the innovation of many frameworks for representing information, and with the beginning of the eighties, the Japanese project began to be announced in implementing the fifth generation of computers, and in it the focus was on computer systems that deal with knowledge in particular, which led to the occurrence of... A breakthrough in artificial intelligence research (Rama, 2016).

Then, artificial intelligence research witnessed a new awakening through the commercial success of expert systems, which is one of the branches of artificial intelligence that were programmed to mimic the decision-making ability of a human expert (Bashir, 2008).

In the early twenty-first century, artificial intelligence achieved greater successes, as it became used in logistics, data mining, medicine, diagnostics, and many fields throughout the technology industry (Amit, 2000).

With the continuous technical progress, computers appeared capable of learning and solving problems. Then researchers and scientists activated a number of programs and equations on a computer to be able to play chess, and it became the first computer to defeat the world chess champion (Ansam, 2022).

Inventions continued, making artificial intelligence an indispensable tool in all different fields of life. Its applications appeared in games and in companies and businesses such as Facebook, Twitter, Twitter, and Netflix. Artificial intelligence has grown to unprecedented levels and is still developing (Christopher, & Benedict, 2005).

3/1- Stages of development of artificial intelligence

3/1/1- Brain cellular networks (neurons or neural networks)

Research in this regard took place in the field of cyberspace in the 1940s, and in the 1950s scientists began to find a machine capable of simulating the human brain, but the technology at that time did not enable them to achieve that goal. As a result, several attempts were made in that period, the most prominent of which was what was known as Perceptual sense, which is a simplified model of the eye's retina through which some specific shapes were recognized, but the capabilities of perceptual sense were narrow and limited, and as a result of that criticism, interest in research in this regard decreased, until interest in it began again in the 1980s in a stronger way (Abdel Hamid, 2005).

3/1/2- Directed search

Scientists started in another direction, where scientists assumed that thinking results from coordination between different tasks that deal with symbols, such as comparing them, searching for them, and modifying them, and through that, a solution to problems can be found by searching for the desired solution from among a large number of possibilities presented. It was decided to present a system called (the general program for resolving issues), but the criticisms directed at them were that...

This program was not based on knowledge and experience in the required field that might contribute to raising and improving the efficiency of the program (Zain, 2000).

3/1/3- Systems based on knowledge representation

Scientists discovered that the human expert has extensive knowledge in fewer topics, so the knowledge and experience that helps in finding a solution to various problems must first be represented. So, the scientists ended up inventing an expert system to interpret the results extracted from the (mass spectrometer), which is one of the devices that a chemist uses in analysis. A program was presented through which the doctor could come up with the required treatment plan. Thus, experience systems were considered one of the most important classifications of artificial intelligence[3].

3/1/4- Machine learning

As a result of the increasing interest in knowledge-based expert systems, a new problem has emerged, which is the method of extracting knowledge or experience. Accordingly, the search for methods of learning from the knowledge possessed by the system began, and from the existing knowledge during its use, scientists arrived at a machine learning system called (EURISKO). (Through it, information is accessed in an automated manner (Inrndv, 2019).

Machine learning is also a branch of artificial intelligence. Learning is the computer's method of using data to learn how to perform a specific function through trial and error. Its goal is to enable machines to think, deduce, and learn like humans (Omar, without year of publication).

Machine learning is the activity of acquiring knowledge or skill through practice, study or experience, and one of its branches is deep learning: it is a subset of machine learning consisting of very large neural networks and a huge set of algorithms that can simulate human intelligence (Abi, et al., 2021).

3/2- Artificial Intelligence Examples for applications

Artificial intelligence has advanced at a tremendous speed in recent years, and its applications have multiplied, covering many areas of life, and it has become difficult to enumerate them. Below is a brief summary of some of them:

In 1996: The world chess champion defeated Kasparov in front of a computer using the Deep Blue program, making him the first computer to defeat the world champion. (Abdel Karim, 2021).

1997: The first self-driving car appeared to cover the distance between Washington and San Diego, United States of America, in record time using the Ralph system. It was an excellent application of artificial intelligence, as the car was able to move at all hours of the day, even in rainy weather. (Joseph, & Hanky, 2022).

In 1999: The American Space Company gave NASA the primary responsibility for driving spacecraft with artificial intelligence systems, which was the first step in space exploration without the need for any human inside the vehicle. (Bijoy, & Ning, 1999).

In the medical field: The first surgical robot was used in Vancouver Hospital, and more than 60 operations were performed in one year. It was also used in diagnosis and treatment, and in the field of nursing to confront the shortage of medical staff.

It was also used in service fields, such as what happened in Abu Dhabi in the United Arab Emirates, with the introduction of the first pharmacy that operates through robots and aims to reduce errors and congestion and reduce waiting time (Ahmed, without year of publication).

To facilitate financial and commercial transactions via the Internet, artificial intelligence has emerged as a role in cognitive services, with the aim of providing financial services in a safer way and making services easier for customers to access.

Artificial intelligence has also witnessed great progress in many fields, such as communications, marketing, training, education, finance, law, and many other fields that are too numerous to mention. (John, 1998).

3/3- Artificial intelligence programs used in universities:

3/3/1-AI Programming Languages and Libraries

3/3/1/1- Python: The Preferred Language for AI Development

Python is the most widely used programming language for AI development due to its simplicity, readability, and extensive library support. It is utilized in creating machine learning models, data analysis, and developing educational applications(Van Rossum, & Drake, 2009).

Python's popularity in AI development stems from its robust ecosystem of libraries and frameworks, making it ideal for educational applications. The language's simplicity allows educators and students to focus on solving problems rather than dealing with complex syntax(Van Rossum, & Drake, 2009)..

a-Key Python Libraries in Education

TensorFlow: Enabling Deep Learning in Education

TensorFlow, developed by Google, is an open-source library for machine learning and deep learning applications. It supports educational tools such as adaptive learning systems and predictive analytics, which enhance personalized learning and administrative efficiency (Abadi, et al., 2016).

Example: The American University in Cairo (AUC) uses TensorFlow to develop AI-powered adaptive learning platforms that customize course content to individual students' needs, enhancing learning outcomes.

Scikit-Learn: Simplifying Machine Learning for Educational Research

Scikit-Learn is a Python library that provides simple and efficient tools for data analysis and machine learning. It is frequently used in educational research to develop and evaluate algorithms that can improve teaching and learning processes (Pedregosa, et al., 2011).

Example: German University in Cairo (GUC) employs Scikit-Learn in research projects to analyze large datasets of student performance and develop predictive models for academic success.

Numpy and Pandas

Numpy and Pandas are essential libraries for numerical computing and data manipulation in Python. They provide powerful data structures that simplify data analysis tasks in educational research (McKinney, 2010).

Example: Misr International University (MIU) uses Numpy and Pandas to handle large datasets in educational research, enabling efficient data analysis and visualization.

b- Applications of Python in Egyptian Universities

AI-Driven Learning Management Systems

Private universities in Egypt are integrating Python-based AI tools into their Learning Management Systems (LMS) to enhance the learning experience.

Example: British University in Egypt (BUE) has integrated a Python-based AI system into its LMS to analyze student interaction data. The system provides personalized recommendations for resources and study plans, improving student engagement and performance.

Intelligent Tutoring Systems

Python is used to develop Intelligent Tutoring Systems (ITS) that provide personalized instruction and feedback to students.

Example: Future University in Egypt (FUE) developed an ITS using Python that offers real-time feedback and customized problem-solving exercises to students in programming courses. This system adapts to each student's learning pace, enhancing their understanding and retention of course material.

Automated Essay Scoring Systems

Python-based AI tools are employed to develop automated essay scoring systems that provide instant feedback on student submissions.

Example: Nile University utilizes a Python-based automated essay scoring system to evaluate student essays. This system uses natural language processing (NLP) techniques to assess the quality of writing, grammar, and coherence, offering immediate feedback to students and reducing the grading workload for instructors.

4- The importance of artificial intelligence in Higher Education

Artificial Intelligence (AI) has become a driving force behind the digital transformation of higher education, serving as a cornerstone for the development of fourth-generation universities. These universities distinguish themselves by integrating advanced technologies to enhance innovation, institutional efficiency, and a comprehensive educational experience for students. AI plays a critical role in improving academic performance and strengthening institutional capacity through data analytics tools that enable universities to make well-informed decisions. These technologies directly contribute to boosting student success rates, identifying those at risk of academic failure, and implementing timely interventions to support them. This approach reduces dropout rates and enhances the overall learning experience (Aoun, 2017).

Moreover, AI enables the delivery of smart, efficient, and personalized student services. Interactive applications, such as chatbots, provide students with swift access to university services, including course registration, fee payment, and timetable management. This reduces administrative burdens on staff and increases student satisfaction. Additionally, these tools offer personalized advice based on student data analysis, supporting students in achieving their academic goals and enhancing their campus experience (Luckin, et al., 2016).

In the realm of scientific research, AI opens new horizons by analyzing large datasets and uncovering complex patterns, which accelerates research processes and fosters innovation. These technologies help researchers produce high-quality studies that enhance the university's reputation and competitive standing (Ahmed, & Hassan, 2023).Advanced laboratories equipped with AI tools also facilitate applied innovations, meeting the needs of both academic and industrial communities (Tejada, & Santos, 2020).

AI's importance extends to improving campus management through smart systems that leverage Internet of Things (IoT) technologies to efficiently manage energy and resources. These systems promote environmental sustainability, with campuses designed to provide suitable, eco-friendly learning environments. Furthermore, AI supports the implementation of blended learning—a core feature of fourth-generation universities—by designing curricula that integrate traditional teaching with advanced technologies such as virtual reality (VR) and augmented reality (AR). This approach provides an innovative educational experience that caters to the diverse needs of students (Molnár, & Szuts, 2018).

Given the challenges faced by higher education globally, such as growing student populations and heightened competition, AI represents a strategic solution for helping universities adapt to these changes. By improving the quality of education, enhancing administrative efficiency, and expanding research and innovation capabilities, universities that adopt AI can remain at the forefront of academic development. This enables them to meet future demands and compete effectively on both local and international levels (van der Zwaan, 2017).

5- literature

Kamel (2016) conducted a study that aimed to design and build an electronic educational system based on artificial intelligence techniques, and measure its effectiveness in developing some statistical analysis skills. The research used the experimental method, where the smart electronic educational system was applied to a sample of postgraduate students at the Faculty of Specific Education at Mansoura University, numbering (64) male and female students. They were divided into two groups: a control group, numbering (34) male and female students, and an experimental group, numbering (34) male and female students. The results confirmed the effectiveness of the proposed smart electronic educational system in developing the statistical analysis skills of the research sample.

Al-Shawabkeh (2017) conducted a study that aimed to identify the role of artificial intelligence applications "expert systems" in making administrative decisions in Saudi banks. To achieve the objectives of the study, the descriptive approach was used. The researcher used a questionnaire consisting of (18) paragraphs after verifying its validity and reliability, distributed to a sample consisting of (83) employees. The results of the study showed that the degree of all dimensions of the independent variable for artificial intelligence applications "expert systems", the suitability of the system, training and development, the smart program used, and the security system, were high.

The study (Luo,2018) focused on the work of Prolo Java and AI language software to prepare a guide for the teaching system based on artificial intelligence, and it was based on the theory of the expert system of artificial intelligence, and at the same time designed the framework of Struts + Spring Hibernate lightweight JavaEE, and the degree of coupling of each unit in the system was greatly reduced to facilitate the expansion of functions for the future based on the principle of teaching the expert system based on artificial intelligence, and the results showed that the system is applicable and useful. It concluded that the artificial intelligence system is effective and has a certain reference significance.

The study of (Hussein et al., 2018) explores the impact of artificial intelligence on the development of e-learning systems, focusing on how to improve the effectiveness of eLearning through the use of artificial intelligence techniques such as machine learning and natural language processing. The study also addressed how to customize educational content for students based on analyzing their behavior and individual needs. The study concluded that the use of artificial intelligence in e-learning contributes significantly to improving students' interaction with educational content and increasing learning effectiveness. The results also indicated that artificial intelligence helps in designing educational systems that are able to adapt to the individual needs of students, which leads to improved academic performance and increased student satisfaction. The study recommended the need to enhance the use of artificial intelligence in e-learning and develop more research to identify best practices in this field.

A study by (Belbaeme et al., 2018) on the use of robots in second language teaching and natural language processing explored how social robots can be used in teaching children a second language, focusing on the role of natural language processing (NLP) in improving the interaction between children and robots. It also aimed to (NLP) in enhancing second language through natural interaction and the study relied on the experimental approach and reached a set of main findings, including the following: Children who interact with robots equipped with natural language processing technologies showed a higher level of language interaction compared to educational activities and interaction with the robot.

Conducted a study in (Al-Yajzi, 2019) that aimed to identify the use of artificial intelligence applications in supporting university education in the Kingdom of Saudi Arabia. This study is a continuation of the research map in educational technology, especially in light of the directions of the Kingdom of Saudi Arabia's vision for the Saudi map 2030, which focuses on employing technology in education. The researcher relied on the inductive approach using the descriptive analytical method through the theoretical analysis of artificial intelligence. The results concluded that the use of artificial intelligence applications in supporting university education in the Kingdom of Saudi Arabia was at a moderate level.

While (Zhao, et al., 2019) conducted a study in China aimed at exploring the impact of using AI-based online teaching systems. To achieve the aim of the study, a descriptive-critical approach based on the analysis of teaching systems was used to analyze the studies that used AI-based online teaching systems. The results indicated that the use of AI-based online teaching systems had a positive impact on students' academic achievement.

Zawacki-Richter et al., (2019) aimed to analyze the role of AI in higher education, focusing on the uses of AI across e-learning and distance education. The study sought to provide a comprehensive overview of how AI technologies impact teaching, learning, and assessment in educational institutions, and to identify trends, opportunities, and challenges associated with the application of AI in education. The study concluded that AI has great potential to improve the quality of higher education by personalizing learning for students, improving assessment processes, and providing interactive educational support. The study also showed an increase in the use of AI in curriculum design, self-directed learning, and educational data analysis. However, the study also noted challenges related to AI ethics, data privacy, and preparing teachers and students to interact with these technologies effectively. The study recommended further research on these challenges and promoting dialogue among policymakers and academics on how to safely and effectively integrate AI into higher education.

A study conducted by (Holmes et al., 2019) found that artificial intelligence contributes significantly to facilitating communication and interaction between students and faculty members through smart communication platforms and instant assessment tools. The study aimed to demonstrate the impact of artificial intelligence programs in improving the process of communication and interaction between students and faculty members. One of the most important results reached by the study is that artificial intelligence plays a major role in improving positive interaction between students and faculty members.

Swati Panda (2019) studied the importance of university brand image as a competitive advantage. The main objectives of this study are:

(To explore the impact of university brand image on student satisfaction levels- United States and India). The results showed that service quality has a greater impact on student satisfaction levels compared to university legacy and reliability. In addition, university reputation was found to have a positive effect as a mediating variable in the relationship between university brand image and student satisfaction levels.

Kool et al., (2019) aimed to explore the impact of AI applications on managerial decision making in organizations. The study focused on how AI technologies, such as machine learning and big data analytics, can be used to support managers in making informed decisions based on accurate data and advanced analytics. The aim of the study was to understand how to improve the quality and efficiency of the decision-making process through the use of smart tools. The study concluded that AI contributes significantly to improving the managerial decision-making process by providing accurate analyses and future predictions that help managers make more informed and effective decisions. The study also showed that the use of AI reduces human bias in decision-making and enhances the ability to handle large and complex data faster and more efficiently.

Abbas, (2020) conducted a study in Iraq that aimed to identify the attitude of university students towards artificial intelligence and its relationship to orientation towards the future. The study sample consisted of (200) male and female students. To achieve the objectives of the study, the descriptive correlational approach was used, and the Artificial Intelligence Scale and the Future Orientation Scale were used, and their validity and reliability were confirmed. The results showed that students have good future expectations and that they believe in scientific cause and development, and that there is cognitive harmony and balance around the nature of orientations and their view of the future.

Al-Awadhi & Abu Latifa (2020) conducted a study in Palestine that aimed to reveal the impact of employing artificial intelligence on developing administrative work in light of governance principles. The study sample consisted of 112 employees who are assigned administrative work in Palestinian ministries. To achieve the objectives of the study, the descriptive analytical approach was used, and the questionnaire was used as a tool for collecting data. The results showed that there is an impact of employing artificial intelligence on developing administrative work in light of governance principles.

The study of (Buah, et al., 2020) conducted in Europe aimed to identify the applications of artificial intelligence in energy systems with a focus on the phenomenon of social acceptance of energy projects. The study sample consisted of (198) male and female volunteers from 15 different countries. To achieve the study objective, the quantitative methodology based on the questionnaire was used, (and the qualitative methodology based on the analysis of the simulation experiment conducted by the system for the energy project. The results of the study showed the existence of an impact of applying artificial intelligence systems on the level of communication and participation in the management of engineering projects, and the innovation of creative solutions to deal with energy-related problems. The results also showed that artificial intelligence applications contribute to providing an opportunity for community participation in influencing the results and outputs of the project from their homes using smart digital technologies.

According to a study by (Shin, et al., 2020), natural language processing techniques have been proven to be effective in analyzing students' text responses. One of the most important findings of the study is that natural language processing (NLP) techniques contribute significantly to the analysis of large texts, which leads to the rapid provision of fast and accurate assessments. The study also concluded that qualitative learning is a modern trend and can be provided specifically based on the individual needs of students. The study followed an experimental methodology based on applying deep learning models to a large set of text data. The researchers used transformer models such as BERT and GPT, and conducted multiple experiments to evaluate the performance of these models on various tasks, such as text classification, information extraction, and sentiment analysis. The models were trained on large data and the results were analyzed using cross-validation techniques to ensure the accuracy of the results.

Min et al., (2021) aimed to develop and improve natural language processing (NLP) models using deep learning techniques, with a focus on improving machine understanding of human language to enable it to process texts more efficiently. The study also sought to improve the accuracy of models in various applications such as machine translation, text analysis, and information retrieval. It relied on an analytical methodology based on multiple experiments using different deep learning models, such as recurrent neural networks (RNNs) and convolutional neural networks (CNNs), in addition to transformer models. These models were trained on large multilingual datasets to improve their ability to process and understand complex texts. The study found that transformer-based deep learning models, such as BERT and GPT, performed significantly better than traditional models in natural language processing. The study also showed that small improvements in model architecture or pre-training techniques can lead to significant improvements in performance. The study recommended continuing research into improving transformer models and using new techniques such as reinforcement learning to increase the effectiveness of natural language processing models.

The study of (Al-Muqaiti, 2021) aimed to explore the reality of employing artificial intelligence and its relationship to the quality of performance of Jordanian universities from the perspective of faculty members. The study focused on understanding how artificial intelligence affects the quality of academic and administrative performance in universities, and identifying the challenges and opportunities associated with the application of this technology. The study relied on the descriptive analytical approach, as questionnaires were distributed to a sample of faculty members in Jordanian universities. The data were analyzed using descriptive and analytical statistical tools to measure the extent of employing artificial intelligence and determine its impact on the quality of performance. The study found that there is an increasing employment of artificial intelligence applications in Jordanian universities, which is positively related to the quality of academic and administrative performance. The results showed that faculty members believe that artificial intelligence contributes to improving the quality of teaching and learning, in addition to enhancing administrative efficiency and decision-making ability.

In a study titled "Enhancing E-Learning Experiences in Higher Education Using AI: A Case Study of European Universities" (Smith & Johnson, 2022), the researchers explored how artificial intelligence (AI) can improve e-learning experiences in European universities. Data from 500 students across three European universities were collected, and machine learning algorithms such as TensorFlow and Python were applied to personalize educational content based on student learning patterns. The results showed a 35% improvement in student comprehension when AI-driven content recommendation systems were used.

"AI-Driven Academic Management: A Study of US Universities" (Brown & Lee, 2023), the focus was on improving academic management processes such as lecture scheduling and student assessment using AI. Data from 10 US universities were analyzed using deep learning algorithms like Keras and Scikit-learn. The results demonstrated a 40% increase in efficiency in time and resource management.

The study, "Predicting Student Performance Using Artificial Intelligence: A Study of Australian Universities" (Taylor and White, 2024[1]), aimed to use artificial intelligence to analyze student performance and predict potential academic challenges. Data from 1,000 students from three Australian universities was analyzed using machine learning algorithms such as XGBoost and Pandas. The results achieved 90% accuracy in predicting student performance.

"Improving International Student Experiences Using AI: A Study of US Universities" (Martinez & Brown, 2025), AI was used to enhance the experiences of international students through real-time translation systems and personalized educational content. Data from 300 international students across five US universities were collected, and an NLP model using tools like Google Translate API and PyTorch was applied. The results showed a 55% improvement in international student satisfaction.

1 Taylor, J., & White, O. (2024). Predicting Student Performance Using AI: A Study of Australian Universities. Australian Journal of Educational Technology, 20(3), 67-81.

Critical Analysis of Previous Studies

Most studies agreed that artificial intelligence (AI) plays a significant role in improving educational and administrative processes. For example, (Kamel, 2016); (Hussein et al., 2018) demonstrated that AI can enhance students' skills and improve their interaction with educational content. Additionally, studies like (Al-Shawabkeh, 2017); (Kool et al., 2019) agreed that AI can enhance efficiency in decision-making and data analysis. Furthermore, studies such as (Zhao et al., 2019); (Zawacki-Richter et al., 2019) highlighted AI's ability to personalize education based on individual student needs, leading to improved academic performance and student satisfaction. Finally, studies like (Shin et al., 2020); (Min et al., 2021) agreed that natural language processing (NLP) techniques can analyze large texts quickly and accurately, helping to provide fast and effective assessments. Recent studies, such as (Taylor and White, 2024), also confirmed that AI can predict student performance with high accuracy (90%), while (Martinez and Brown, 2025) showed that AI improves international student satisfaction by 55% through personalized content and real-time translation systems.

The studies differed in several aspects, including the methodologies used. For instance, (Kamel, 2016) relied on an experimental approach, while (Al-Shawabkeh, 2017) used a descriptive approach. The sample sizes and compositions also varied; (Kamel, 2016) used a relatively small sample (64 students), while (Zhao et al., 2019) relied on a critical analysis of previous studies without a specific sample. Additionally, some studies focused on specific applications, such as e-learning (Kamel, 2016) or decision-making (Al-Shawabkeh, 2017), while others explored broader applications like text analysis (Shin et al., 2020) or academic performance improvement (Hussein et al., 2018). Recent studies like Taylor and White (2024) focused on predictive analytics, while (Martinez and Brown, 2025) emphasized AI's role in enhancing international student experiences, showing a divergence in focus areas. Lastly, the studies differed in addressing ethical and technical challenges; (Zawacki-Richter et al., 2019) highlighted these challenges, while other studies, including the more recent ones, did not address them sufficiently.

6- The Gap

The application of artificial intelligence in higher education is a growing field globally, with many universities aiming to leverage these technologies to enhance academic and administrative performance. However, research addressing the use of AI in Egyptian universities remains limited, and there are no comprehensive studies that reflect the unique challenges faced by Egyptian universities while providing tailored solutions to meet their specific needs.

Currently, Egyptian universities lack an integrated framework that outlines how to adopt AI in a way that supports various aspects of academic and administrative operations. These aspects include the **prediction of student performance**, which helps in early identification of students needing academic support; **intelligent communication**, which improves the speed and efficiency of communication between students and university administrations; **exam monitoring** to ensure academic integrity and reduce opportunities for cheating; and **support for student**

activities, which enhances student engagement and their overall educational experience.

Moreover, current research lacks methodological tools for self-assessment in AI applications within Egyptian universities. Such tools would provide a mechanism for measuring progress in implementing AI technologies, allowing universities to review their performance and identify areas that require continuous improvement.

Thus, the research gap lies in the absence of a comprehensive framework and self-assessment guide to assist Egyptian universities in achieving effective and integrated AI implementation. This study aims to bridge this gap by developing a proposed framework for AI application in Egyptian universities, along with actionable assessment standards that enable universities to monitor and improve their performance in this field, in alignment with their local needs and technological advancement requirements.

7- Research Methodology

7/1- Research Approach

The researcher presented the methodology of the field study through the variables of the study and its dimensions, identifying the type and sources of data, identifying the study community and sample, data collection methods, and the statistical methods used that were relied upon in analyzing the field study data. The nature of the study requires relying on the appropriate method that achieves its objectives, so the researcher resorted to using the descriptive analytical method that is concerned with studying the phenomenon and analyzing it to reach accurate conclusions about the phenomenon and its interpretation, and depends on studying the problem as in practical reality, and is concerned with describing it accurately and analyzing it quantitatively and qualitatively, and linking information about the problem and interpreting and analyzing it in a way that leads to accurate conclusions about the problem and ways to treat it, and the researcher reviews the methodology of the study by clarifying the variables of the study and its dimensions, identifying the type and sources of data and the study sample, data collection methods, and statistical analysis methods that were relied upon in analyzing the field study data.

The researcher can display the study dimensions for the variable (Artificial Intelligence), which includes four dimensions as follows: (natural language processing, machine learning, computer vision, robotics).

7/2- Data Collections Tools

To achieve the study's objectives, two primary sources of data were relied upon, as follows:

Secondary Data: The secondary data utilized in this study to achieve its objectives were determined in light of the study's problem and the related variables. The researcher relied on the following sources for collecting secondary data: Arabic and foreign references, published and unpublished research related to the study topic.

Arabic and foreign journals, newsletters, reports, and various statistics.

Annual reports issued by the Egyptian universities under study and application.

Primary data: The researcher developed a field application to address the analytical aspects and survey opinions on the study topic through an opinion poll directed to a sample of faculty members at Egyptian universities. The data resulting from the poll were collected, classified and tabulated to facilitate their analysis and interpretation to extract results and recommendations. The obtained data were analyzed using appropriate statistical methods to test the validity of the study hypotheses, in addition to conducting some personal interviews.

7/3-. Study community and sample:

The researcher relied on the survey method as a tool for collecting data. The data collection tool is represented by the survey list directed to faculty members at Egyptian universities. The survey includes the following:

- The first section: relates to the variable "Artificial Intelligence" and its dimensions are: (Natural Language Processing, Machine Learning, Computer Vision, Robotics), and the total number of phrases of the variable as a whole is (20) phrases.
- The second section: relates to the variable " Practices for applying AI in Egyptian Universities", and the total number of phrases of the variable as a whole is (5) phrases.

The researcher also conducted some personal interviews when collecting the survey from faculty members at Egyptian universities, in order to know the extent of the application of artificial intelligence in Egyptian universities.

(a) Study community:

The study community consists of all faculty members in private universities in Egypt, numbering (14414), who work in (31) private universities (October for Modern Sciences and Arts, Misr International, Misr for Science and Technology, October 6, American, Al-Ahram Canadian, British, French, Pharos, Egyptian Russian, Modern for Technology and Information, Sinai, German, Future, Nahda, Delta for Science and Technology, Heliopolis, Badr, Derayah, New Giza, Horus, Egyptian Chinese, Egyptian Japanese, Zewail, Sphinx, Merit, Al-Salam, New Salhia, Al-Hayat, Badr Assiut, May), and (6) private universities in Egypt were selected for study and application, namely: "October 6 University, Sinai University, Badr University, Future University, New Giza University, Heliopolis University". These six universities were selected for their distinguished scientific and academic reasons. October 6 University is one of the oldest and largest private universities in Egypt, with a strong reputation and advanced infrastructure. Sinai University is distinguished by its strategic location in the Sinai Peninsula and its specialized programs in medical and engineering sciences, which contribute to the development of the region. Badr University is considered one of the emerging universities that focuses on innovation and scientific research and provides modern facilities for students. Future University is known for its distinguished academic programs and has a presence in international rankings thanks to the quality of education and international cooperation. New Giza University offers study programs in partnership with international universities and supports scientific research and innovation in a unique location. As for Heliopolis University, it focuses on sustainable development and provides specialized educational programs in this field, making it a pioneer in supporting environmental sustainability in Egypt. The selection of these universities reflects the diversity and balance between academic quality, scientific research, and innovation in higher education in Egypt.

The researcher conducted a field study on them, and the following table shows the components of the study community as follows:

Table No. (1): Study community vocabulary

	Study community / Universities vocabulary	Faculty members
1	6th October University	968
2	Sinai University	561
3	Badr University	555
4	Future university	446
5	New Giza University	238
6	Heliopolis University	203
Total		2971

Source: Prepared by the researcher based on the universities under study and application

It is clear from the previous table that the study community in the private universities in Egypt, the subject of the study and application, amounted to (2971) individuals.

(b) Study sample:

In light of the study community vocabulary table, the researcher relied on a random sample of faculty members at the private universities under study and application, numbering (2971) individuals. By examining the tables to determine the sample size for the study community (2000), it became clear that the sample size was (322) individuals. As for examining the study community (3000), it became clear that the sample size was (346) individuals. For considerations of the study sample representing the study community, the researcher relied on the sample size (346) individuals. The following table shows the distribution of the study sample size among the private universities in Egypt under study and application as follows:

Table No. (2): Distribution of the sample size of faculty members in private universities in Egypt under study and application

	Universities / Study community and sample	Study community	The study sample	
1	6th October University	968	364× 968 /2971= 112	32.4%
2	Sinai University	561	346×561/2971= 65	18.8%
3	Badr University	555	346×555/2971= 65	18.8%
4	Future university	446	346×446/2971= 52	15%
5	New Giza University	238	346×238/2971= 28	8.1%
6	Heliopolis University	203	346×203/2971= 24	6.9%
Total		2971	346	100%

Source: Prepared by the researcher based on the universities under study.

It is clear from the previous table that the study sample consisted of (346) faculty members in the private universities in Egypt, the subject of the study and application, in order to identify their opinions and suggestions regarding the dimensions of the variables under study. The total number of correct responses from faculty members reached (346) items, at a rate of (100%).

(c) Description of the study sample:

The researcher described the study sample through the demographic variables represented by: “academic degree, gender, number of years of experience, age” in light of the category, number and percentage. The following table shows a description of the demographic variables of the study sample as follows:

Table No. (3)
Description of demographic variables of the study sample

Demographic variables	Category	Number	percentage
Degree	Teaching Assistant	16	4.6%
	Assistant Lecturer	70	20.2%
	Lecturer	135	39.1%
	Assistant Professor	95	27.4%
	Professor	30	8.7%
	Total	346	100%
Type	Males	154	44.5%
	Females	192	55.5%
	Total	346	100%
Years of Experience	Less than 5 years of experience	19	5.5%
	6:10 years of experience	64	18.5%
	11:15 years of experience	129	37.3%
	16:20 years of experience	98	28.3%
	20+ years of experience	36	10.4%
	Total	346	100%
Age	Less than 30 years	94	27.2%
	31:40 years	133	38.4%
	41:50 years	81	23.4%
	Over 50 years	38	11%
	Total	346	100%

Source: Prepared by the researcher based on the results of the statistical analysis

The previous table shows that the total study sample amounted to (346) individuals, and with regard to the academic degree variable, there were (16) individuals in the teaching assistant’s category, (4.6%), (70) individuals in the assistant lecturer category, (20.2%), (135) individuals in the instructor category, (39.1%), (95) individuals in the assistant professor category, (27.4%), and (30) individuals in the professor category, (8.7%). With regard to the gender variable, the number of males was (154) individuals, (44.5%), and the number of females was (192) individuals, (55.5%). With regard to the number of years of experience, the number of members with less than 5 years of experience was (19) individuals, (5.5%), and the category of members with 6:10 years of experience was (64) individuals, (18.5%), and the category of members with 11:15 years of experience was (129) individuals, (13.5%). (37.3%), and the category of members from 16 to 20 years of experience is (98) individuals at a rate of (28.3%), and the category of members more than 20 years of experience is (36) individuals at a rate of (10.4%), and with regard to the age variable, there are (94) individuals in the age group less than 30 years at a rate of (27.2%), and the age group from 31 to 40 years is (133) individuals at a rate of (38.4%), and the age group from 41 to 50 years is (81) individuals at a rate of (23.4%), and the age group more than 50 years is (38) individuals at a rate of (11%).

7/4-Validity & Reliability

Validity: The correlation coefficient of the score of each item with the total sum of the items of each dimension was calculated. The following table shows the values of the correlation coefficients between the score of each item and the total score of the dimension to which it belongs as follows:

Table No. (4)

Correlation coefficients between the score of each item and the total score of the dimension to which it belongs

Natural language processing			Machine learning		Computer vision		Robotics	
	Correlation coefficient		Correlation coefficient		Correlation coefficient		Correlation coefficient	
1	0.753**	6	0.783**	11	0.750**	16	0.753**	21
2	0.835**	7	0.735**	12	0.835**	17	0.750**	22
3	0.760**	8	0.655**	13	0.865**	18	0.783**	23
4	0.848**	9	0.786**	14	0.814**	19	0.789**	24
5	0.835**	10	0.809**	15	0.865**	20	0.821**	25

Source: Prepared by the researcher based on the results of the statistical analysis
****Statistically significant at the (0.01) level.**

The following table shows that all correlation coefficient values are positive and statistically significant at a significance level of (0.01), as the values of the correlation coefficients of each item's score with the total score of the natural language processing dimension ranged between (0.753, 0.848), and the values of the correlation coefficients of each item's score with the total score of the machine learning dimension ranged between (0.655, 0.809), and the values of the correlation coefficients of each item's score with the total score of the computer vision dimension ranged between (0.750, 0.865), and the values of the correlation coefficients of each item's score with the total score of the robotics dimension ranged between (0.750, 0.821), and the values of the correlation coefficients of each item's score with the total score of the Egyptian universities dimension ranged between (0.497, 0.887), and all of these values are statistically acceptable, and therefore no item was deleted from these items, which indicates the existence of a good relationship between the score of each item and the total score of the dimension to which the item belongs.

Reliability: To estimate the reliability of the survey, the Cronbach's alpha and split-half methods were used. The following table shows the values of the Cronbach's alpha and split-half reliability coefficients for each dimension of the survey as follows:

Table No. (5)

Values of Cronbach's alpha reliability coefficients and the split-half for each dimension of the survey

Artificial Intelligence			Half-split stability coefficients	
	Dimensions	Cronbach's alpha reliability coefficients	Getman equation	Spearman Brown
1	NLP	0.913	0.882	0.886
2	Machine learning	0.855	0.868	0.871
3	Computer vision	0.922	0.881	0.885
4	Robotics	0.873	0.866	0.873

Source: Prepared by the researcher based on the results of the statistical analysis

The previous table shows that the values of the Cronbach's alpha stability coefficients for the dimensions of the study variables came in the range (0.835, 0.922), and that the values of the split-half stability coefficients before correction according to the Getman equation came in the range (0.742, 0.882), and after correction according to the Spearman-Brown equation came in the range (0.756, 0.886), and all of these are statistically high coefficient values, which confirms the stability and validity of the survey's use and its suitability for the purposes of the study.

7/5-Artificial Intelligence measurement Model Test

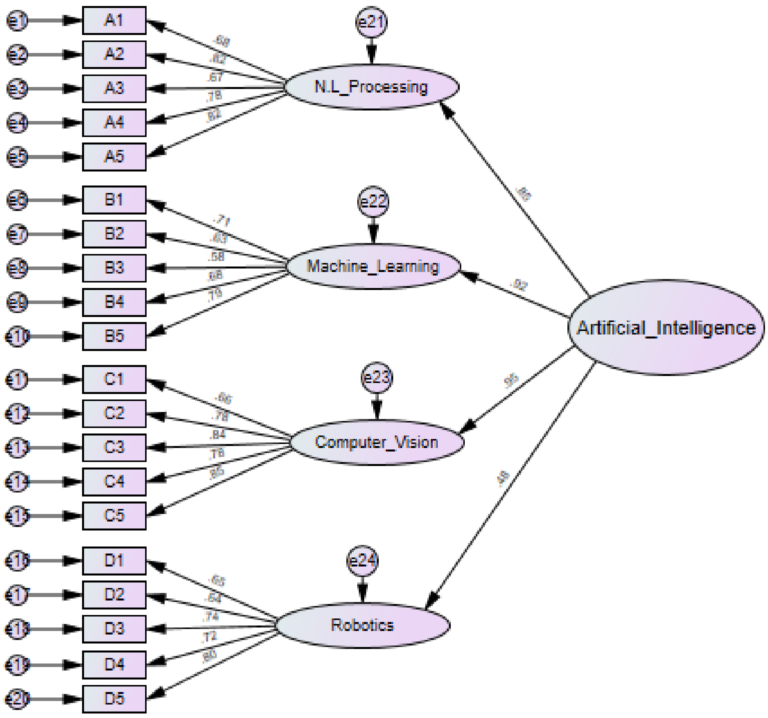
Grounded in the theoretical framework, the Artificial Intelligence (AI) measurement model (Shown in Figure [2] was conceptualized as a hierarchical structure with 'Artificial Intelligence' (Artificial Intelligence) serving as a second-order factor. This second-order factor encompasses four distinct first-order latent dimensions: Natural Language Processing (Natural Language Processing), Machine Learning (Machine Learning), Computer Vision (Computer Vision), and Robotics (Robotics).

Variable	*Dimension*	*Statements*	*Reference*
Artificial Intelligence	**Natural Language Processing**	- Utilizing NLP expertise to solve complex operational challenges.	Hirschberg, & Manning, C. D. (2015). Advances in natural language processing. Science.
		- Implementing NLP as an expert consultant to support decision-making.	Jurafsky, & Martin, (2021). Speech and Language Processing. Pearson.
		- Using NLP to streamline technical processes in decision-making workflows.	Young, et al., (2018). Recent trends in deep learning based

Variable	*Dimension*	*Statements*	*Reference*
			natural language processing
		- Driving innovation and creativity in university services through NLP.	Cambria, & White, (2014). Jumping NLP curves: A review of natural language processing research.
	Machine Learning	- Applying ML to process and analyze vast amounts of information.	Domingos, (2012). A few useful things to know about machine learning. Communications of the ACM.
		-Adopting ML to derive insights from accurate data in dynamic scenarios.	Jordan, & Mitchell, (2015). Machine learning: Trends, perspectives, and prospects.
		-Improving the quality of university services through ML-driven insights.	Alpaydin, (2020). Introduction to Machine Learning.
	Computer Vision	-Using Computer Vision to access options for complex, non-numerical problems.	Goodfellow, et al., (2016). Deep Learning.
		-Adapting Computer Vision to match evolving university needs and environments.	Redmon, & Farhadi, (2018). YOLOv3: An incremental improvement.
		-Reducing operational costs of services provided to university stakeholders through Computer Vision.	He, et al., (2016). Deep residual learning for image recognition.
	Robotics	Utilizing robotics to reduce time in achieving operational goals.	Siciliano, & Khatib، (Eds.). (2016). Springer Handbook of Robotics.
		Employing robotics as decision-making agents in pre-defined scenarios.	Thrun, et al., (2005). Probabilistic Robotics.
		Substituting robotics for human agents to minimize operational costs.	Brooks, (1991). Intelligence without representation.
		Using robotics to enhance the quality of services provided by the university.	Bekey, (2005). Autonomous Robots: From Biological Inspiration to Implementation and Control.

Source: Prepared by the researcher

Figure [1]: Initial AI measurement model



Source: Prepared by the researcher using AMOS

Rigorous evaluation of the model was undertaken through Confirmatory Factor Analysis (CFA) utilizing AMOS v26. Initial CFA results indicated suboptimal model fit, with indices (CMIN/DF = 5.551, GFI = 0.801, NFI = 0.789, RFI = 0.758, IFI = 0.820, TLI = 0.793, CFI = 0.819, and RMSEA = 0.115) falling below the established thresholds for acceptable fit as outlined by Hu and Bentler (1999) and Browne and Cudeck (1992).

To address this, iterative model refinement procedures were implemented to achieve satisfactory fit. Two distinct refinement approaches were employed: one involving multiple refinement cycles, and another utilizing a single iterative refinement process. The model demonstrating superior fit indices was ultimately selected.

7/5/1- multiple refinement cycles approach

Multiple refinement cycles for the AI measurement model involved a three-step process:

- ❖ Examination of items loadings: Assessing the strength of the relationship between observed variables and their respective latent factors.
- ❖ Analysis of modification indices: Identifying potential modifications to the model structure suggested by the software to improve model fit.
- ❖ Inspection of standardized residual covariances: Investigating unexpected relationships between variables that were not accounted for in the initial model specification.

7/5/1/1- Examination of items loadings

Table [6]: Items loadings

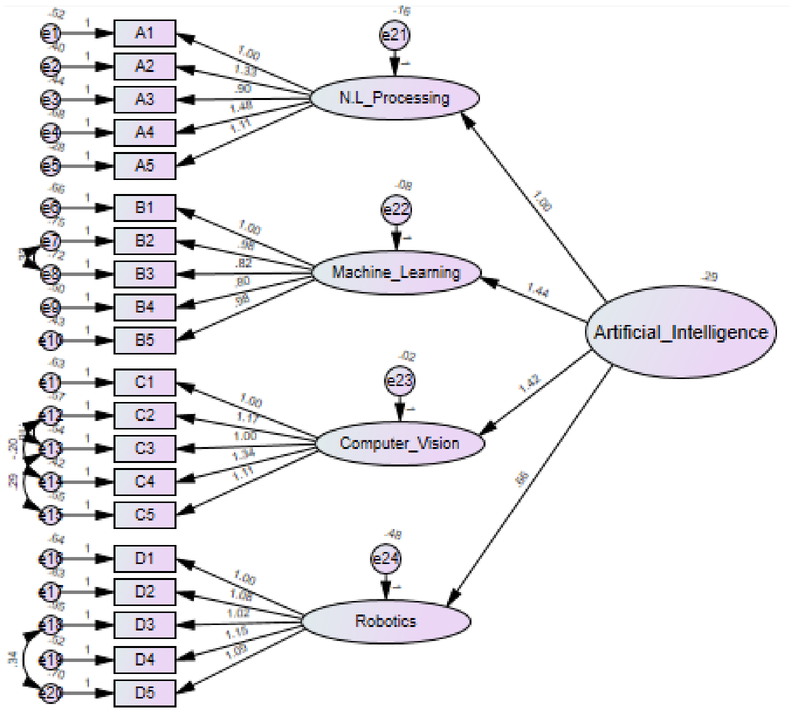
Factor	Item	Loading	Item	Loading
Natural Language Processing	A1	.680	A4	.776
	A2	.816	A5	.816
	A3	.667		
Machine Learning	B1	.715	B4	.678
	B2	.634	B5	.792
	B3	.583		
Computer Vision	C1	.661	C4	.776
	C2	.784	C5	.845
	C3	.843		
Robotics	D1	.654	D4	.719
	D2	.644	D5	.803
	D3	.741		

Source: Prepared by the researcher based on the results of the statistical analysis

A thorough examination of the items loadings revealed that all items exhibited loadings exceeding the 0.5 threshold (detailed in Table NO [6], indicative of a strong relationship with their respective latent factors. As such, no items were deemed necessary for exclusion from the model. Consequently, the model structure remained unaltered, resulting in no change to the initial fit indices (CMIN/DF = 5.551, GFI = 0.801, NFI = 0.789, RFI = 0.758, IFI = 0.820, TLI = 0.793, CFI = 0.819, and RMSEA = 0.115).

7/5/1/2- Analysis of modification indices

Figure [2]: AI Model after addressing misspecifications within the single-factor framework



Source: Prepared by the researcher using AMOS

To address potential model misspecifications within the single-factor framework, modification indices were consulted. Specifically, model refinements were pursued with the objective of achieving a chi-square reduction of at least 20 units. Following five iterations of model refinement guided by these indices (Shown in Figure [2]), no further modifications with the potential to achieve a chi-square reduction exceeding this threshold were identified. Despite these efforts, the model's fit indices remained unsatisfactory (CMIN/DF = 4.287, GFI = 0. 851, NFI = 0. 842, RFI = 0. 813, IFI = 0. 874, TLI = 0. 850, CFI = 0. 873, and RMSEA = 0.098). A summary of the five refinement steps, including the associated changes in fit indices, is presented in Table [7].

Table [7]: Fit indices during addressing misspecifications within the single-factor framework

Refinement	Reduction	CMIN/DF	GFI	NFI	RFI	IFI	TLI	CFI	RMSE
		< 3	≥ 0.9	≥ 0.9	≥ 0.9	≥ 0.9	≥ 0.9	≥ 0.9	< 0.08
NO Refinement		5.551	.801	.789	.758	.820	.793	.819	.115
e18<--> e20	20.891	5.366	.812	.797	.766	.828	.801	.827	.113
+ e13--> <e15	50.360	4.948	.829	.814	.784	.846	.820	.845	.107
+ e7<-->e8	43.381	4.650	.835	.826	.797	.858	.834	.857	.103
+e12<-->e13	34.006	4.452	.843	.835	.806	.867	.843	.866	.100
+e12<-->e14	21.211	4.287	.851	.842	.813	.874	.850	.873	.098

Notes: CMIN/DF = discrepancy divided by degree of freedom; GFI = Goodness of Fit Index; NFI = Normed Fit Index; RFI = Relative Fit Index; IFI = Incremental Fit Index; TLI = Tucker-Lewis coefficient; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation

Source: Prepared by the researcher based on the results of the statistical analysis

7/5/1/3- Inspection of standardized residual covariances

Building upon the results of the previous step, which yielded unsatisfactory fit indices of CMIN/DF = 4.287, GFI = 0.851, NFI = 0.842, RFI = 0.813, IFI = 0.874, TLI = 0.850, CFI = 0.873, and RMSEA = 0.098, the refinement process proceeded.

In the first stage, items exhibiting standardized residual covariances exceeding 2 with other items were iteratively deleted. Standardized residual covariances, obtained by dividing each residual covariance by an estimate of its standard error, are expected to follow a standard normal distribution in sufficiently large samples under a correctly specified model. In this context, most standardized residual covariances should be less than two in absolute value. This stage resulted in acceptable levels for the GFI, IFI, and CFI indices, while the CMIN/DF, NFI, RFI, TLI, and RMSEA indices remained unsatisfactory.

Subsequently, a second stage of refinement was conducted, involving the iterative deletion of items with standardized residual covariances exceeding 1. This stage led to acceptable levels for the NFI and TLI indices, in addition to the GFI, IFI, and CFI indices achieved in the first stage. However, the CMIN/DF, RFI, and RMSEA indices remained below acceptable thresholds. A summary of the two refinement stages, including the associated changes in fit indices, is presented in Table [8].

Table [8]: Fit indices during inspection of standardized residual covariances

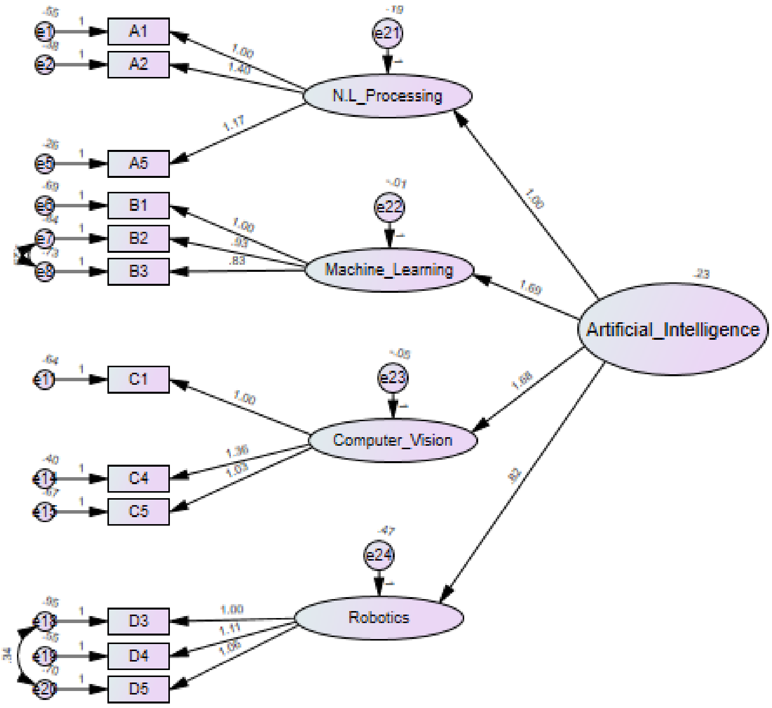
Stage	Elimination	with	S.R.C	CMIN/DF	GFI	NFI	RFI	IFI	TLI	CFI	RMSE
				< 3	≥ 0.9	≥ 0.9	≥ 0.9	≥ 0.9	≥ 0.9	≥ 0.9	< 0.08
0	previous step			4.287	.851	.842	.813	.874	.850	.873	.098
1	Eliminate B5	D3	2.444	4.369	.816	.845	.815	.876	.851	.875	.099
		D5	2.771								
	+ B4	A3	2.133	3.944	.878	.867	.838	.897	.874	.896	.092
		A1	3.121								
	+ D1	C1	2.744	4.003	.886	.874	.845	.903	.879	.902	.093
		B3	3.11								
	+ D2	B3	-3.314	3.996	.896	.885	.855	.911	.887	.910	.093
		B2	2.205								
	+ C3	B2	2.564	3.731	.906	.889	.860	.916	.893	.916	.089
		A4	2.343								
2	+ A3	D5	-1.959	4.006	.908	.892	.859	.916	.891	.916	.093
		D4	-1.875								
		D3	-1.130								
		C4	-1.660								
		C1	1.599								
	+ A4	D3	1.853	4.276	.911	.893	.856	.916	.886	.915	.097
		C5	1.603								
		C2	1.125								
	+ C2	D4	-1.667	3.787	.926	.910	.876	.932	.906	.932	.090
		C5	1.004								
		B3	-1.606								
		B2	-1.040								
		A2	1.463								
		A1	1.642								

Notes: CMIN/DF = discrepancy divided by degree of freedom; GFI = Goodness of Fit Index; NFI = Normed Fit Index; RFI = Relative Fit Index; IFI = Incremental Fit Index; TLI = Tucker-Lewis coefficient; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation

Source: Prepared by the researcher based on the results of the statistical analysis

A minimum of three measurement items was maintained for each of the four dimensions throughout the item deletion process. The deletion process for an individual dimension ceased upon reaching three remaining measurement items. Consequently, the overall deletion process was terminated when this criterion was met for all dimensions (Shown in Figure [3]), despite the model's fit indices not attaining acceptable levels for all indices.

Figure [3]: AI Model at the end of inspection of standardized residual covariances



Source: Prepared by the researcher using AMOS

This two-stage process represents the culmination of multiple refinement cycles for the artificial intelligence measurement model, resulting in a final set of fit indices: CMIN/DF = 3.787, GFI = 0.926, NFI = 0.910, RFI = 0.876, IFI = 0.932, TLI = 0.906, CFI = 0.932, and RMSEA = 0.090.

7/5/2- Single iterative refinement process approach

In contrast to the multiple-step approach, which employed a combination of strategies such as evaluating items loadings, standardized residual covariances, for item deletion, alongside the use of modification indices to address within-factor item covariances, the single iterative refinement process approach exclusively employed sequential item deletion guided solely by modification indices. Specifically, at each iteration, the item exhibiting the largest number of covariances and discrepancy with other items, as indicated by the modification indices, was systematically deleted. This iterative process continued until acceptable model fit indices were achieved. A summary the sequential item deletion refinement guided by modification indices, including the associated changes in fit indices, is presented in Table [9].

Table [9]: Fit indices during sequential item deletion refinement guided by modification indices

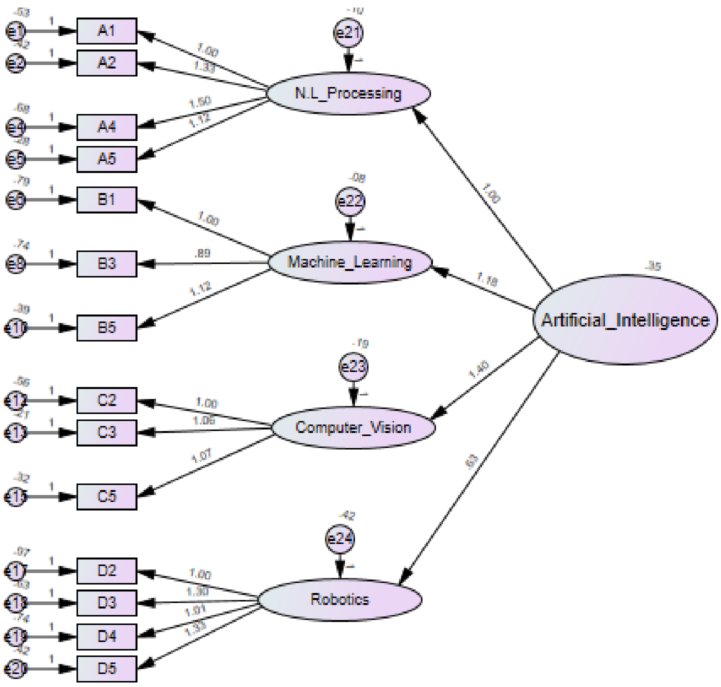
Refinement	CMIN/DF	GFI	NFI	RFI	IFI	TLI	CFI	RMSE
	< 3	≥ 0.9	≥ 0.9	≥ 0.9	≥ 0.9	≥ 0.9	≥ 0.9	< 0.08
NO Elimination	5.551	.801	.789	.758	.820	.793	.819	.115
Eliminating C4	4.881	.824	.815	.786	.847	.822	.846	.106
+ B2	4.220	.853	.846	.820	.878	.857	.877	.097
+ D1	4.193	.866	.857	.831	.887	.866	.886	.096
+ C1	3.807	.885	.878	.854	.907	.888	.906	.090
+ B4	2.919	.913	.912	.892	.940	.926	.940	.075
+ A3	2.891	.921	.920	.900	.946	.932	.946	.074

Notes: CMIN/DF = discrepancy divided by degree of freedom; GFI = Goodness of Fit Index; NFI = Normed Fit Index; RFI = Relative Fit Index; IFI = Incremental Fit Index; TLI = Tucker-Lewis coefficient; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation

Source: Prepared by the researcher based on the results of the statistical analysis

This approach adheres to the same constraint as the preceding multi-step approach: a minimum of three measurement elements must be retained for each dimension. The item deletion process is terminated upon reaching three measurement elements per dimension, irrespective of whether acceptable model fit indices have been attained.

Figure [4]: AI Model after sequential item deletion refinement guided by modification indices



Source: Prepared by the researcher using AMOS

Based on the iterative process of item deletion guided by modification indices, the model achieved acceptable levels of fit indices (CMIN/DF = 2.891, GFI = 0. 921, NFI = 0. 920, RFI = 0. 900, IFI = 0. 946, TLI = 0. 932, CFI = 0. 946, and RMSEA = 0. 074). Consequently, the process was terminated without enforcing a minimum number of items for the two dimensions, Natural Language Processing and Robotics (Shown in Figure [4].

7/5/3- Representation of the AI measurement model

The AI measurement model resulting from the multi-step optimization cycle exhibited suboptimal model fit, as evidenced by unacceptable values for critical indices such as CMIN/DF = 3.787, RFI = 0.876, and RMSEA = 0.090. In contrast, the model refined through an iterative elimination process guided by modification indices (Shown in Figure [4], demonstrated acceptable fit (CMIN/DF = 2.891, GFI = 0. 921, NFI = 0. 920, RFI = 0. 900, IFI = 0. 946, TLI = 0. 932, CFI = 0. 946, and RMSEA = 0. 074). Consequently, the latter model was selected as the final representation of the AI measurement model.

Final AI Measurement Items of Dimensions of Artificial Intelligence

Dimension	Practice	(1) Not practiced	(2) Practiced to a minimal degree	(3) Practiced to an acceptable degree	(4) Practiced to a good degree	(5) Practiced to the highest degree
1.Natural Language Processing	Utilizing NLP expertise to solve complex operational challenges.					
	Implementing NLP as an expert consultant to support decision-making.					
	Using NLP to streamline technical processes in decision-making workflows.					
	Driving innovation and creativity in university services through NLP.					
2. Machine Learning	Applying ML to process and analyze vast amounts of information.					
	Adopting ML to derive insights from accurate data in dynamic scenarios.					
	Improving the quality of university services through ML-driven insights.					
3. Computer Vision	Using Computer Vision to access options for complex, non-numerical problems.					
	Adapting Computer Vision to match evolving university needs and environments.					
	Reducing operational costs of services provided to university stakeholders through Computer Vision.					
4.Robotics	Utilizing robotics to reduce time in achieving operational goals.					

Dimension	Practice	(1) Not practiced	(2) Practiced to a minimal degree	(3) Practiced to an acceptable degree	(4) Practiced to a good degree	(5) Practiced to the highest degree
	Employing robotics as decision-making agents in pre-defined scenarios.					
	Substituting robotics for human agents to minimize operational costs.					
	Using robotics to enhance the quality of services provided by the university.					

Source: Prepared by the researcher.

8-Testing Hypothesis

H1: "*The model expressing using Ai in Egyptian universities is significant*."

The selected model demonstrated acceptable fit (CMIN/DF = 2.891, GFI = 0. 921, NFI = 0. 920, RFI = 0. 900, IFI = 0. 946, TLI = 0. 932, CFI = 0. 946, and RMSEA = 0. 074).

To verify the validity of this hypothesis, Pearson's correlation coefficient was calculated between the dimensions of artificial intelligence in Egyptian universities. The following table shows the matrix of correlation coefficients between the dimensions of artificial intelligence in Egyptian universities as follows:

Table No. (7)

Matrix of correlation coefficients between the dimensions of artificial intelligence in Egyptian universities.

Dimensions	NLP	ML	Computer vision	Robotics
NLP	1.00	0.655**	0.719**	0.392**
ML	0.655**	1.00	0.778**	0.380**
Computer vision	0.719**	0.778**	1.00	0.402**
Robotics	0.392**	0.380**	0.402**	1.00

Source: Prepared by the researcher based on the results of the statistical analysis
****Statistically significant at the (0.01) level.**

The previous table shows the following:

The correlation coefficients presented in the matrix reveal statistically significant relationships (at the 0.01 level) between the dimensions of Artificial Intelligence in Egyptian universities. Specifically:

- Natural Language Processing (NLP) demonstrates a strong positive correlation with Machine Learning (ML) (0.655**) and Computer Vision (0.719**) and a moderate correlation with Robotics (0.392**).
- Machine Learning (ML) exhibits a very strong correlation with Computer Vision (0.778**) and a moderate correlation with Robotics (0.380**).

- Computer Vision shows a strong correlation with NLP (0.719**) and ML (0.778**) while maintaining a moderate correlation with Robotics (0.402**).
- Robotics has moderate positive correlations with NLP (0.392**), ML (0.380**), and Computer Vision (0.402**).

These findings underscore the interconnected nature of AI dimensions, emphasizing how advancements in one domain can significantly influence and complement the others, thereby creating a cohesive and integrated framework for applying AI in universities.

9.Discussion

9/1-Overview of Results

This section discusses the results reached through analyzing the impact of applying the dimensions of AI in Egyptian universities.

- The results showed the validity of the hypothesis, which is: "*The Model expressing that using Artificial Intelligence in Egyptian universities is significant*."

Results of the statistical study

The correlation coefficients presented in the matrix reveal statistically significant relationships (at the 0.01 level) between the dimensions of Artificial Intelligence in Egyptian universities. Specifically:

- Natural Language Processing (NLP) demonstrates a strong positive correlation with Machine Learning (ML) (0.655**) and Computer Vision (0.719**) and a moderate correlation with Robotics (0.392**).
- Machine Learning (ML) exhibits a very strong correlation with Computer Vision (0.778**) and a moderate correlation with Robotics (0.380**).
- Computer Vision shows a strong correlation with NLP (0.719**) and ML (0.778**) while maintaining a moderate correlation with Robotics (0.402**).
- Robotics has moderate positive correlations with NLP (0.392**), ML (0.380**), and Computer Vision (0.402**).
- The AI measurement model resulting from the multi-step optimization cycle exhibited suboptimal model fit, as evidenced by unacceptable values for critical indices such as CMIN/DF = 3.787, RFI = 0.876, and RMSEA = 0.090. In contrast, the model refined through an iterative elimination process guided by modification indices (Shown in Figure [5], demonstrated acceptable fit (CMIN/DF = 2.891, GFI = 0. 921, NFI = 0. 920, RFI = 0. 900, IFI = 0. 946, TLI = 0. 932, CFI = 0. 946, and RMSEA = 0. 074). Consequently, the latter model was selected as the final representation of the AI measurement model.

General results of the study

- The results confirmed that universities applying AI dimensions, including machine learning, natural language processing, computer vision, and robotics, achieve outstanding academic performance, which is reflected in improving the quality of academic programs and increasing satisfaction among students and faculty.
- The study proved that universities' reliance on AI-driven technologies in education and student affairs management significantly contributes to enhancing their ability to compete locally and internationally.

9/2-Comparison of Results

The present study aligns with a growing body of research exploring the integration and impact of artificial intelligence (AI) in various educational and administrative contexts. Numerous studies have emphasized the potential of AI technologies to enhance learning outcomes, optimize decision-making processes, and improve administrative efficiency in diverse sectors, including education, banking, and energy systems. This section provides a comparative analysis of the current research findings with those of previous studies, focusing on key dimensions such as the methodologies employed, target populations, and significant outcomes.

Kamel (2016) demonstrated the efficacy of AI-driven electronic educational systems in developing statistical analysis skills among postgraduate students. Similarly, Hussein et al. (2018) highlighted the transformative role of AI in e-learning through techniques such as machine learning and natural language processing, emphasizing enhanced interaction and tailored content for learners. These findings resonate with the current study's aim of exploring the role of AI in advancing educational quality and administrative efficiency.

Studies like Al-Shawabkeh (2017) and Al-Awadhi & Abu Latifa (2020) explored the impact of AI applications in administrative decision-making and governance. Their results indicated significant enhancements in decision-making quality and adherence to governance principles, mirroring the current research's focus on operational efficiency and decision-making improvements in university settings.

Further, (Zawacki-Richter et al., 2019) and Holmes et al. (2019) examined AI's role in higher education, revealing its potential to personalize learning, improve assessments, and facilitate communication between students and faculty. These studies share a thematic overlap with the present research, which seeks to uncover AI's contributions to both academic and administrative domains.

On the technical front, (Luo, 2018) and Min et al. (2021) showcased advancements in AI models and frameworks, particularly in natural language processing and educational system design. Their findings underline the importance of leveraging state-of-the-art AI technologies to enhance system efficiency and adaptability, which is also a focal point of the current study.

The diverse applications of AI in energy systems (Buah et al., 2020) and second-language teaching (Belbaeme et al., 2018) underscore the interdisciplinary nature of AI research. While these studies fall outside the direct scope of educational management, they contribute to a broader understanding of AI's transformative capabilities.

Through this comparative analysis, the present study builds upon existing research while addressing gaps related to AI applications in private universities in Egypt, particularly concerning competitive advantage dimensions such as cost leadership, differentiation, innovation, and operational efficiency.

10-Summary

This study aims to develop a framework for the application of artificial intelligence (AI) dimensions in Egyptian universities. The research investigates how various AI dimensions, such as machine learning, natural language processing, and robotics, can be integrated to enhance the academic and administrative environment in universities. By examining both theoretical and practical aspects, the study explores the potential of AI in transforming educational processes and improving institutional performance.

As these institutions evolve to incorporate advanced technologies and modernize their educational approaches, the study examines the role of AI in improving academic and administrative operations. It explores how the application of AI can contribute to achieving goals such as operational efficiency, academic excellence, and innovation in Egyptian universities.

The primary objectives of the research include identifying the relationship between AI dimensions, analyzing the role of AI in achieving these objectives, and proposing strategies for Egyptian universities to adopt and leverage AI tools for continuous improvement. Through this framework, the study addresses gaps in the current academic environment and provides a comprehensive guide for universities to maintain competitiveness in an increasingly digital and globalized world.

The research findings offer a comprehensive understanding of how AI, can contribute to the success and development of Egyptian universities, particularly fourth-generation universities.

11-A Framework for Applying AI in Egyptian Universities

Depending on the gap of the study in literature, we recommend using the following Framework for Applying AI in Egyptian Universities:

Criterion	Description	Objectives	Indicators	Rules and Policies	Academic Impact	Outcomes
Technological Infrastructure	Provide high-speed, fully covered internet, equip classrooms with smart labs, and use cloud computing for data storage and management.	- Improve internet speed and connection efficiency. - Provide a smart learning environment. - Facilitate access to academic data and content.	- High-speed internet network fully covered. - Classrooms equipped with smart labs and sensors. - Cloud computing systems for data storage.	- Implement cloud computing standards. - Ensure network performance across the campus.	- Improve access speed to academic content. - Enhance the experience of students and faculty in education.	- Increase student access to educational resources. - Provide an integrated learning environment.
Blended Learning	Integrate electronic learning with traditional education using platforms like Blackboard and Moodle.	- Enhance flexibility in education. - Improve learning experiences using modern technologies.	- Use of learning management platforms like Blackboard or Moodle. - Design interactive content enhanced with virtual or augmented reality.	- Implement policies to manage blended learning. - Ensure technical support for students and faculty in using platforms.	- Improve the effectiveness of education. - Increase student engagement with educational content.	- Provide a flexible learning environment that enables students to learn more effectively.

Criterion	Description	Objectives	Indicators	Rules and Policies	Academic Impact	Outcomes
Artificial Intelligence in Education	Use AI to analyze student data and provide solutions for predicting their academic performance and improving learning levels.	- Use AI to support academic decisions. - Improve student academic performance.	- AI systems to predict student performance. - Robotics and software supporting student inquiries (chatbots). - Applications to analyze student data.	- Apply privacy and security standards for student data. - Continuously develop AI algorithms.	- Improve academic decision-making. - Increase student success and engagement rates.	- Improve the learning experience through the use of AI tools in the classroom.
Smart Facilities Management (IoT)	Use Internet of Things (IoT) devices to monitor university facilities, such as controlling temperature, lighting, and security solutions.	- Improve management of university facilities. - Provide a safe and efficient campus environment. - Reduce energy consumption.	- Smart energy management systems. - IoT devices to monitor campus environment (temperature, lighting). - Smart security systems with surveillance cameras.	- Apply smart energy management policies. - Create data protection policies in IoT systems.	- Improve energy consumption efficiency. - Enhance campus security.	- Reduce operational costs and increase security. - Improve comfort for students and faculty.
Scientific Research and Innovation	Provide labs equipped with the latest technologies to support scientific research, and use AI for data analysis and accelerating research processes.	- Enhance innovation and scientific research. - Improve the effectiveness of research in universities.	- Labs equipped with advanced technologies. - AI programs to analyze research data. - Partnerships with technology companies to support applied innovation.	- Implement policies to support scientific research and collaboration with the private sector. - Develop mechanisms for optimal use of technology in research.	- Enhance the university's ability to innovate. - Improve the quality of scientific research.	- Support technological innovation and improve academic research quality.

Source: Prepared by the researcher

The proposed model represents a comprehensive framework for implementing artificial intelligence (AI) and advanced technologies in universities, focusing on meeting the standards of smart and fourth-generation universities. It aims to integrate technology into academic and administrative processes, enhancing the quality of education and research while achieving operational efficiency within universities.

Technological infrastructure forms the foundation of this model, ensuring universities provide high-speed internet that covers the entire campus, facilitating seamless access to academic content and efficient data exchange among stakeholders. Classrooms are equipped with smart labs featuring advanced technologies, alongside the adoption of cloud computing systems for effective data management and analysis, enabling data-driven decision-making.

Blended learning reflects a shift from traditional teaching models by combining electronic learning with face-to-face education through platforms such as Blackboard and Moodle. This approach offers greater flexibility for both students and faculty while supporting the design of interactive content enhanced with virtual and augmented reality, fostering engagement and enriching the learning experience.

Artificial intelligence in education is a central pillar of the model, utilized for analyzing student data and offering recommendations to improve academic performance. AI applications predict student outcomes, facilitate academic decision-making, and include tools such as chatbots for addressing student inquiries. These technologies enhance the learning process and support universities in adopting data-informed strategies for improved academic results.

Smart facilities management, leveraging Internet of Things (IoT) technologies, plays a crucial role in monitoring and managing university facilities effectively. IoT devices control lighting, temperature, and security systems, optimizing energy consumption and providing a safe and sustainable campus environment. This component reduces operational costs while ensuring the comfort and security of campus users.

Finally, the model emphasizes scientific research and innovation as a cornerstone of academic excellence. It provides state-of-the-art labs to support research activities and employs AI tools for data analysis, accelerating research processes. Partnerships with the private sector foster applied innovation, strengthening universities' capacities to address real-world challenges and improve research quality.

Overall, the model demonstrates how universities can transform into smart, advanced institutions that balance cutting-edge technology with the demands of academic and research excellence. It enhances operational efficiency and improves the experiences of all stakeholders, contributing to higher university rankings both locally and internationally.

12- Recommendations

Based on the findings of this study, which aims to develop a framework for the application of artificial intelligence in Egyptian universities, this research highlights the critical role AI can play in transforming educational and administrative processes. The results demonstrate that artificial intelligence, through its diverse applications such as machine learning, natural language processing, and robotics, holds significant potential to improve the quality of education, streamline administrative operations, and enhance the overall academic experience for students and faculty members.

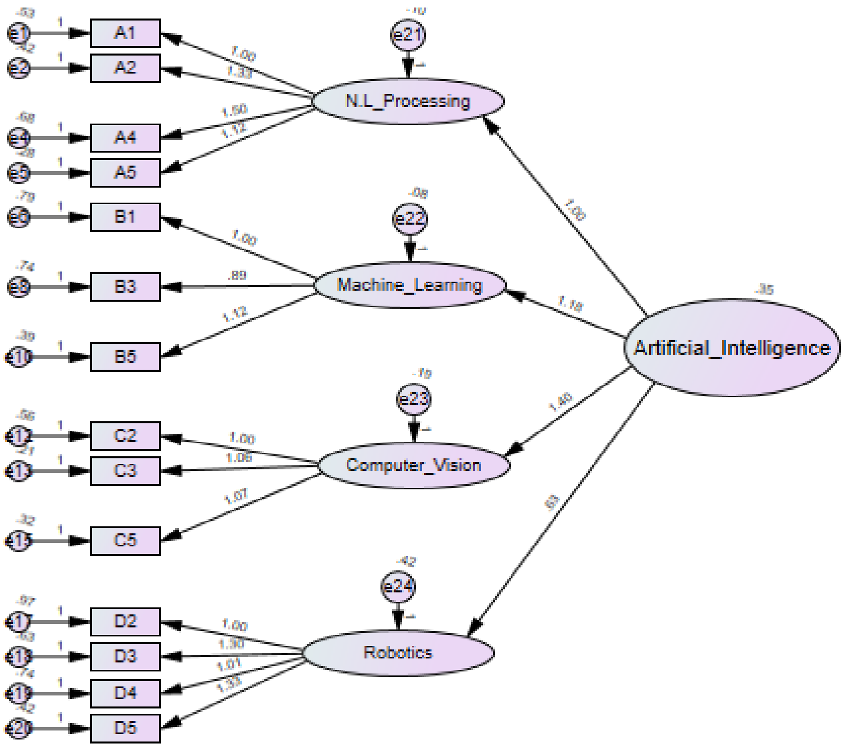
While the adoption of AI technologies in universities faces challenges, including limitations in technical infrastructure and resistance from some stakeholders, the study reveals considerable opportunities for leveraging these tools to increase competitiveness among Egyptian universities on both national and international levels. The integration of AI aligns with the goals of establishing fourth-generation universities and adhering to international standards for quality in higher education.

The following recommendations are grounded in the study's findings and provide a strategic roadmap for implementing artificial intelligence effectively. These recommendations aim to guide Egyptian universities in enhancing their academic and administrative practices, fostering innovation, and ensuring sustainable competitive advantages in an increasingly technology-driven educational landscape.

An AMOS model was employed to analyze the dimensions of artificial intelligence, which include [list the dimensions: such as machine learning, natural language processing, computer vision, and robotics]. The model was applied to the collected data to evaluate the impact of these dimensions on academic practices in private universities.

The analysis resulted in the structural figure illustrated in Figure 5, which represents the relationship between artificial intelligence dimensions and the extent of universities' practices in the academic process.

Figure [4]: AI Model after sequential item deletion refinement guided by modification



Source: Prepared by the researcher using AMOS

It is recommended that universities adopt this model as a self-assessment tool to evaluate their use of artificial intelligence in academic operations. This model can assist universities in identifying strengths and weaknesses in their application of AI technologies, thereby improving education quality and enhancing operational efficiency.

The final AI measurement model, as refined through an iterative elimination process guided by modification indices (Figure [4]), provides a robust framework for evaluating the implementation of artificial intelligence in academic practices. This model demonstrated acceptable fit indices, including CMIN/DF = 2.891, GFI = 0.921, NFI = 0.920, RFI = 0.900, IFI = 0.946, TLI = 0.932, CFI = 0.946, and RMSEA = 0.074, making it a reliable tool for assessment.

It is recommended that universities adopt this optimized model as a baseline for their self-assessment processes. Specifically, the model can be utilized to:

- Identify critical dimensions of AI implementation that require enhancement.
- Monitor progress over time by comparing fit indices from periodic evaluations.
- Develop targeted interventions to address areas of weakness highlighted by the measurement model, ensuring continuous improvement in academic practices through AI integration.

By leveraging this refined measurement model, universities can ensure a data-driven approach to aligning their academic operations with global standards in smart and fourth-generation universities.

Recommendations for applying self-assessment for applying AI in Egyptian universities

Practice	Incubator (1 point)	Initiative (3 points)	Integrated (9 points)	Score
Technological Infrastructure	Basic internet network with limited coverage, and no strong cloud systems.	High-speed internet network with broader coverage in certain areas, beginning use of cloud computing for data storage.	Advanced infrastructure including ultra-fast internet coverage throughout the campus, integrated cloud systems for data support, and smart devices like interactive screens and labs.	
Blended Learning	Offering limited online courses with basic LMS support for students.	A variety of online courses integrated with face-to-face learning and use of platforms like Moodle or Blackboard for both administrative and academic tasks.	Fully integrated, AI-enhanced blended learning systems with immersive content (VR/AR) and highly personalized student learning paths and assessments.	
Artificial Intelligence in Education	Limited use of AI tools for tracking student performance, with no complete system integration.	AI systems used for tracking and analyzing student performance with some academic interventions to improve results.	Full AI application including performance prediction and personalized learning solutions, interactive learning through smart robots, and performance tracking apps.	
Smart Facility Management (IOT)	Basic technologies like IoT devices to monitor environmental factors in public areas.	Advanced energy management systems and some smart devices to control temperature and lighting in buildings.	Fully integrated smart systems for energy management using IoT devices, precise environmental monitoring, and energy-efficient designs for educational spaces.	
Scientific Research and Innovation	Limited application of AI in research, such as basic data analysis tools in specific fields.	Application of AI in some research labs and academic processes, integrating advanced analysis tools to support innovation.	Full-scale use of AI in scientific research with advanced data analysis tools accelerating innovation, in collaboration with technology companies to support applied research.	
Smart Student Services	Limited applications such as student registration systems or inquiry chatbots, offering only basic services.	Partial integration of student services like e-payment, inquiry management, and smart applications for academic and administrative services.	Comprehensive smart student services including registration, academic inquiries, interaction with the university via mobile apps, remote health services, and AI-powered communication.	
Total score				

Source: Prepared by the researcher

13-Future Research

Building on the findings of this research, several avenues for future studies are proposed to deepen the understanding of Artificial Intelligence (AI) applications in universities. Future research can explore how AI technologies such as Natural Language Processing and Machine Learning can enhance personalized learning by adapting to diverse student needs and preferences. Additionally, studies could investigate the integration of AI with emerging technologies, including blockchain, IoT, and augmented reality, to create more interactive and efficient learning environments.

Further research may also focus on AI's role in promoting sustainable campus management, such as energy optimization and waste reduction, contributing to the development of smart and green universities. Ethical considerations and the formulation of comprehensive policies for AI use in higher education, addressing data privacy and algorithmic bias, remain critical areas for exploration.

Longitudinal studies examining the lasting impact of AI on student outcomes, such as academic performance, engagement, and career readiness, could provide valuable insights. Moreover, comparative studies across traditional, smart, and fourth-generation universities could highlight best practices and identify transferable lessons. Investigating AI's potential to support faculty development and foster inclusive education for students with disabilities or special needs further broadens the scope of its applications.

Finally, global trends and cross-cultural analyses of AI implementation in universities could enrich understanding of its effectiveness and challenges in varied contexts, contributing to a more comprehensive perspective on leveraging AI to reshape education and enhance institutional competitiveness.

This integrated approach to future research emphasizes the transformative potential of AI in education and aligns with the evolving demands of smart and innovative university models.

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