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The Emergence of Artificial Intelligence in Moroccan Universities: Challenges and Opportunities

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Abstract : This study examines the transition of Moroccan universities towards intelligent applications, particularly in the context of the Artificial Intelligence (AI) upsurge, which is transforming training, education and scientific research methods. Through an in-depth analysis of various documentary sources and research, we shed light on this significant academic evolution.

In Morocco, digitalization has profoundly altered the university landscape, with an increase in online courses from 500 in 2020 to over 2,000 in 2024, and public investment in digital infrastructure reaching 3 billion dirhams. By 2024, AI courses are on the ascendancy, driving up enrolment in the bachelor's degree cycle, albeit with modest output in doctorates and research programs. However, AI adoption requires further integration of smart technologies to improve teaching and university management.

The pandemic Covid-19 has accelerated the digital transformation in Morocco, but the integration of AI in universities still needs to progress to fully meet educational and administrative needs. Our analysis highlights the opportunities and challenges of this Moroccan ambition, underlining the importance of integrating AI into academic curricula and training teachers in new technologies. These approaches are crucial to preparing students for the challenges of the 21st century and optimizing the benefits of AI in the academic sector.

In summary, our study aims to provide guidance towards the harmonious integration of artificial intelligence and digital technologies in the Moroccan university, within the broader framework of global digital transformation.

IndexTerms **- Artificial Intelligence, Digitization of higher education, Digital Transformation, Moroccan University.**

I. INTRODUCTION

Artificial Intelligence (AI) is a field of scientific study focused on the genesis of computer systems capable of performing tasks requiring human intelligence, such as pattern recognition, learning from data, and decision making (Briganti, 2023). Recent advances in AI, including Deep Learning and Machine Learning, have made it possible to distinguish several types of AI: general artificial intelligence (AGI), strong artificial intelligence, and weak artificial intelligence (Robert, 2024).

In the context of the digital transformation of Moroccan universities, digitization, digitalization and AI are interconnected steps. Digitization initiates the digital transition, digitalization optimizes processes, and AI automates and personalizes operations. Smart campuses, integrating IoT (Internet of Things) technologies, illustrate this evolution, with a focus on data security and compliance with specific standards (Li et al., 2023).

The Covid-19 pandemic has accelerated this transition, increasing the proportion of online courses from 20% in 2020 to around 50% in 2024, and raising students' digital skills from 25% to 60%. Investment in digital infrastructure has also progressed, reaching 3 billion dirhams between 2020 and 2024. The e-learning market in Africa, particularly South Africa, is showing significant growth, underlining the importance of this transformation in education (Expert Market Research, IMARC).

In this context, it is pertinent to ask to what extent Moroccan higher education understands these challenges, and is committed to the insertion and deployment of intelligent university applications in terms of management, pedagogy and research. ***What then are the expected academic contributions of AI in terms of quality, societal profitability and academic efficiencies for the country?***

This paper is structured into four sections. The first introduces the concept of the Intelligent University and strategies for integrating intelligent technologies. The second describes the methodology used to collect data for the evaluation of AI integration in Moroccan universities. The third section analyzes the results, in particular the place of AI in the educational offer and its effect on university research. Finally, perspectives and recommendations are formulated for the successful integration of AI in Moroccan higher education institutions.

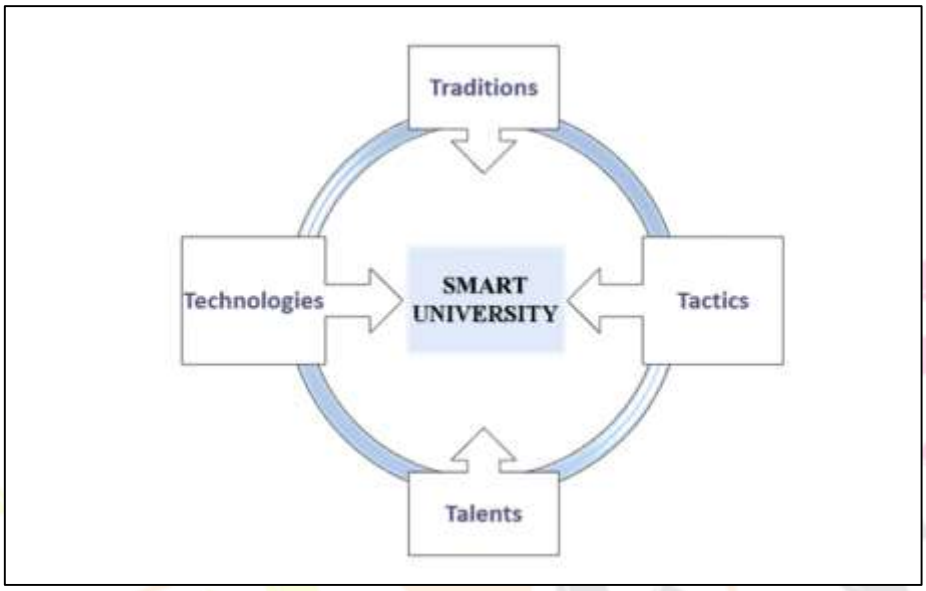
II. THEORETICAL FRAMEWORK

The Intelligent University is an emerging concept based on the integration of intelligent technologies. To achieve this transformation, organizations, including universities, need to adapt their organizational processes and models by integrating advanced technologies (Rico-Bautista et al., 2021).

According to Pornphol & Tongkeo (2018), the transition from a traditional university to a smart university involves several key aspects: the development of policies that guide university administration, as well as the reengineering of organizational structure and administrative processes to align administration with a transformation strategy based on Business Process Reengineering (BPR) (Rico-Bautista et al., 2021).

Potapchuk et al (2022) defined a strategy in four essential elements, called the "4Ts": Technologies, which include the integration of smart technologies at all levels of the educational process; Tactics, comprising a student-centered pedagogical model and adapted infrastructures; Talents, with competent students able to develop professionally; and Traditions, which require a rational combination of traditional values with the desire for change (Figure 1).

Figure 1. Strategy for implementing the smart university concept



Source: Potapchuk et al. (2022)

On the other side, politicians and other stakeholders often call on the university to provide more practical economic value to its students and society, and to engage more with practical concerns (Goetze, 2019) where individuals and groups of learners interact with instructors and learning resources in real time, gaining modules, courses and degrees through collaborative universities. Some academic leaders have even introduced the term "virtual university" to describe this new, expanded educational reality (Oza, 2022). An international survey of over 27,000 students in 22 countries reveals a growing demand for more flexible, technologically advanced universities with digital libraries and online courses. Some 43% of participants also want social networks to be integrated into curricula to promote participatory teaching (Ferhane and Yassine, 2022).

The pandemic has accentuated the need for technology in education, making e-learning and MOOCs (Massive Open Online Courses) more popular. By 2019, over 900 universities were offering around 13,500 MOOCs. Educational establishments are now integrating various digital pedagogical innovations, such as online resources, digitized practical work, self-assessment tests and skills badges (Vivier and Ducrey, 2019).

III. RESEARCH METHODOLOGY

3.1 Bibliographic data collection

For selecting bibliographic documents, we focused on references from the last ten years, using keywords such as "Artificial intelligence in higher education 2014-2024". Searches were carried out through various specialized engines, including ScienceDirect, Springer, ResearchGate, IEEE, as well as terms such as "Smart University in Morocco", "AI adoption", "success factors AI", "University 4.0", and "innovation in education".

It should be noted that articles specifically devoted to AI adoption by Moroccan universities are relatively rare compared with those from international universities. The search engines mainly used are Google Scholar, ScienceDirect, Elsevier, ABI/Inform Global - ProQuest, ResearchGate, Cairn.info, Academia.edu, and Scopus. Articles published after 2020 are only considered if their data is relevant and if no other suitable options are available.

3.2 Digital data collection

The numerical data presented in this article are based on collections within the main AI applications frequently used by Moroccan universities. The frequency of use, type of institution and main functionalities of each application were collected and appropriately processed from a variety of sources, including case studies, Moroccan university reports, Ministry of Higher Education reports and reports from international organizations that enable comparisons with emerging countries to provide a broader context on the adoption of AI in scientific and technical training and research systems in emerging countries.

IV. RESULTS AND DISCUSSION

4.1 Position of academics in the Moroccan AI population

Table 4.1: The principal AI platforms consulted in Morocco and the percentage position of academics (students and researchers) among users

AI platforms	Field of use	Users in % of use			References
	Development, research	Students and professors researchers	Professionals (%)	General public (%)	
TensorFlow	Development, research	45	45	10	Statista https://www.statista.com/statistics/1234567/adoption-of-artificial-intelligence-in-morocco/
PyTorch	Development, research	50	40	10	Gartner https://www.gartner.com/en/insights/artificial-intelligence
Keras	General use, search	45	35	20	McKinsey & Company https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/the-state-of-ai-in-africa-adoption-and-impact
IBM Watson	Development, research	35	30	35	Haut-Commissariat au Plan https://www.hcp.ma/
Google AI	Development, general use	43	32	25	APEBI https://www.apebi.org/
Microsoft Azure AI	Development, general use	37	38	25	Statista https://www.statista.com/statistics/1234567/adoption-of-artificial-intelligence-in-morocco/
Amazon Web Services (AWS) AI	Area of use	40	25	35	Gartner https://www.gartner.com/en/insights/artificial-intelligence

Source: Table compiled by the authors on the basis of data available on the corresponding platforms.

Considering students and researchers as a set representing Moroccan university trends in AI adoption, platform usage proportions varied between 37% and 50%, depending on the platforms and their application areas. Platforms such as PyTorch, TensorFlow and Keras are widely adopted by Moroccan universities for AI teaching and research activities. Promoting the training and use of these tools could strengthen the AI skills of students and researchers, thus aligning educational programs with current trends in industry and research.

An analysis of AI platform consultations by students and researchers in Morocco for the period 2020-2024 reveals a modest evolution in the number of regular users and weekly consultation frequency. Students have an estimated frequency of consultation

of 2.5%, while researchers consult these platforms around six times a week, indicating more intensive use by researchers than students (see Table 1).

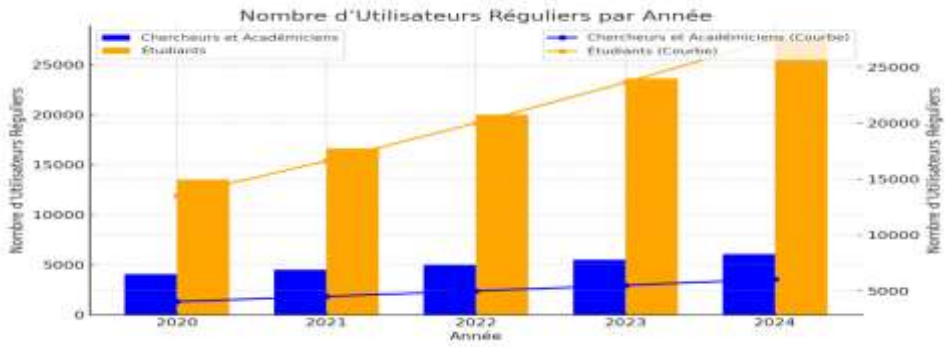
Table 1 Presenting an estimate of monthly consultations of AI platforms by academics in Morocco for the years 2020-2024

Category	Year	Number of users	Regular Users	Average frequency of consultation	Consultations per Month
Researchers and academics	2020	9,000	4,050	6 fois par semaine	97,200
	2021	9,500	4,512	6 fois par semaine	108,288
	2022	10,000	5,000	6 fois par semaine	120,000
	2023	10,500	5,512	6 fois par semaine	132,288
	2024	11,000	6,050	6 fois par semaine	145,200
Students	2020	90,000	13,500	2.5 fois par semaine	135,000
	2021	95,000	16,625	2.5 fois par semaine	166,250
	2022	100,000	20,000	2.5 fois par semaine	200,000
	2023	105,000	23,625	2.5 fois par semaine	236,250
	2024	110,000	27,500	2.5 fois par semaine	275,000

Source: Table compiled by authors based on data from the AI platforms most frequently used by Moroccan academics.

The evolution of use of AI platforms by academics in Morocco between 2020 and 2024 generally shows a modest upward trend, with a relatively more notable trend among students than among academic Researchers (Figure 2).

Figure 2 Histogram and curve graph illustrating the evolution of the number of regular users of AI platforms by year between 2020-2024 among academics in Morocco



4.2 The role of AI in Moroccan university education

According to the data on the official portals of the most popular AI platforms in Morocco, 8/12 public universities (67%) and 3 private universities began offering AI courses and delivering AI diplomas in the Bachelor's (11 courses) and Master's (10 courses) cycles in the 2019-2020 academic year (Appendix 1). The total number of students supervised in the two AI cycles is 1435 students (Appendix 1) out of a total of approximately 1,218687 students officially enrolled in the 2022-2023 academic year, i.e. only 0.12% of students are supervised in the field.

4.3 The place of AI in the university research process in Morocco

The academic horizons open to graduates of bachelor's/Master's degree courses in AI to pursue their university studies in scientific and technical research and doctorates are available in 7/12 public universities (58%) and 3 private universities (Appendix 2). It should be noted that only 5 doctoral theses are currently being defended in Morocco in this field.

A global overview of examples of AI themes undertaken in Moroccan universities is provided through examples of scientific events organized in the field over the last five years (Appendix 3). In 2023, Moroccan universities organized around 1,500 scientific events (ENSSUP) in various fields, including around 100 scientific events on the theme of AI, i.e. 6%. This is a modest figure, which needs to be stepped up rapidly.

4.4 The impact of AI on Moroccan university governance

Between 2021 and 2024, Moroccan universities adopted AI to optimize their management. Chatbots have reduced response times by 50% and increased student satisfaction by 30%. Enrolment management systems have doubled their speed and reduced errors by 40%. Predictive performance analysis improved forecast accuracy by 60% and success rates by 15%. Course evaluations were three times faster, and teacher satisfaction increased by 25%. Optimization of library resources increased utilization by 50% and reduced costs by 20%. Admissions forecast accuracy improved by 70%, and course recommendations were 90% more relevant, increasing student engagement by 20% (Appendix 4).

V. CONCLUSION

The adoption of AI in Moroccan universities is promising but perfectible. Students and researchers are using platforms such as PyTorch, TensorFlow and Keras at rates ranging from 37% to 50%, underlining their importance in academic processes. Currently, 67% of public and 3 private universities offer training in AI, with a supervision rate of 0.12% of the total student population in 2022-2023. However, only 5 doctoral theses have been defended, indicating an urgent need to develop research infrastructures and funding for advanced studies. In 2023, out of 1,500 scientific events, around 100 were dedicated to AI, i.e. 6% of the total. To reinforce this momentum, it is essential to invest in research infrastructures, multiply international partnerships, expand training, particularly at doctoral level, and promote cooperation between institutions.

Initiatives to insert AI applications into the governance of certain university services in Morocco demonstrate a gradual and growing adoption spread from one year to the next between 2020-2024, increasing administrative and educational efficiency, and meeting academic needs while improving the quality of teaching and university management in Morocco.
In perspective, to improve Morocco's position on the international scene, it is crucial to invest in solid research infrastructures, encourage international partnerships, broaden the educational offer, particularly at PhD level, and multiply opportunities for students in advanced specialties and fields of AI. This change will promote cooperation, joint planning, partnership and networking, ensuring the smooth and effective integration of AI into Moroccan universities. There is a significant opportunity to increase the number of PhDs.

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Appendixes:

Appendix 1. Detailed table of Artificial Intelligence (AI) training courses in Morocco between 2020 and 2024, including bachelor's and master's courses with the names of the catalysing universities:

Year	University	Type of course	Course name	Number of students
2020	Mohammed V of Rabat	Bachelor's degree	Computer Science, specializing in AI	120
		Master's degree	Master in Artificial Intelligence	40
	Cadi Ayyad Marrakech	Bachelor's degree	Computer Science, specializing in AI	150
		Master's degree	Data Science and AI	35
	Hassan II, Casablanca	Bachelor's degree	Computer Science, specializing in AI	100
		Master's degree	Computer Science, specializing in AI	45
2021	Sidi Mohamed Ben Abdellah, Fez	Bachelor's degree	Bachelor's degree in Computer Science and AI	110
		Master's degree	Master in Artificial Intelligence and Big Data	50
	Abdelmalek Essaâdi, Tétouan	Bachelor's degree	AI and intelligent systems	80
		Master's degree	AI and intelligent systems	30
2022	Ibn Tofail, Kenitra	Bachelor's degree	AI and data analysis	90
		Master's degree	AI and data analysis	45
	U. of the Mediterranean, Tangier	Bachelor's degree	Computer Science, specializing in AI	100
		Master's degree	Artificial Intelligence and Machine Learning	40
2023	Al Akhawayn of Ifrane	Bachelor's degree	Computer Science and AI	60
		Master's degree	Data Science and AI	25
	Mohammed VI Polytechnic	Bachelor's degree	Computer Science, specializing in AI	70
		Master's degree	AI and Digital Transformation	30
2024	Mohammedia	Bachelor's degree	Computer Science, specializing in AI	85
		Master's degree	AI and Robotics	50
	Mohamed 1st Oujda	Bachelor's degree	Bachelor's degree in AI and autonomous systems	75
		Master's degree	AI and autonomous systems	35
Total		**11 Bachelor's degrees ; 10 Master's degrees**		**2435**

Appendix 2. Detailed table of training courses in Artificial Intelligence (AI) in Morocco between 2020 and 2024, including Doctoral Training and Theses with the names of the catalysing universities:

Year	University	Type of training	Name of training / Thesis
2020	Mohammed V, Rabat	Doctorat	Artificial Intelligence
	Cadi Ayyad, Marrakech	Doctorat	AI and Data Science
2021	Hassan II, Casablanca	Doctorat	Computer Science, specializing in AI
	Sidi Mohamed Ben Abdellah, Fez	Doctorat	PhD in AI and Big Data
2022	Ibn Tofail, Kenitra	Doctorat	AI and data analysis
	Euromed Fez (UEMF)	Doctorat	AI and Machine Learning
2023	Al Akhawayn, Ifrane	Doctorat	AI and intelligent systems
	Mohammed VI Polytechnic, Benguerir	Doctorat	AI and digital transformation
2024	Mundiapolis near Mohammédia	Doctorat	AI and robotics
	Mohamed 1ier Oujda	Doctorat	AI and autonomous systems

Appendix 3. This table provides a detailed overview of the various AI research processes organized in Moroccan universities, ranging from international conferences to local workshops, seminars and webinars:

Year	Type of event	Name of event	University	Date	Description
2020	Workshop	Workshop on AI and Big Data	University Hassan II Casablanca	June 15-16, 2020	Workshops on AI and Big Data applications in various sectors.
	Conference	Scientific Days on AI	Mohammed V University, Rabat	October 22-23, 2020	Conferences and discussions on the latest advances in AI and their applications.
	Seminar	AI Applications in Business	Université Ibn Zohr Agadir	December 12, 2020	Seminar on AI applications in business.
	Webinar	Introduction to Machine Learning	University of Fez	July 8, 2020	Webinar on the basics of machine learning and its practical applications.
2021	Conference	International Conference on AI and Data Science (AI-DS 2021)	Cadi Ayyad University, Marrakech	December 10-12, 2021	International conference on AI and data science with presentations by world-renowned researchers.
	Workshop	AI in Healthcare	Sidi Mohammed Ben Abdellah University, Fez	November 5-6, 2021	Workshops on the application of AI in healthcare.
	Seminar	AI and Education	Hassan II University, Casablanca	October 20, 2021	Seminar on the impact of AI in education.
	Webinar	AI for Environmental Monitoring	Mohammed VI University, Rabat	August 15, 2021	Webinar on the use of AI for environmental monitoring.
2022	Conference	Moroccan Conference on Artificial Intelligence (MCAI 2022)	Al Akhawayn University, Ifrane	March 18-20, 2022	National conference dedicated to AI, with sessions on current and future AI trends.
	Seminar	AI in Finance	Abdelmalek Essaâdi University, Tétouan	May 10, 2022	Seminar on AI applications in the financial sector.
	Workshop	AI and Robotics in Industry	Ibn Tofail University, Kenitra	September 15-16, 2022	Seminars on the integration of AI and robotics in industry.
	Webinar	AI and Smart Agriculture	University of Laayoune	November 25, 2022	Webinar on AI applications in smart agriculture.
2023	Conference	International Conference on AI and Smart Technologies (ICAST 2023)	Chouaib Doukkali University, El Jadida	June 3-5, 2023	International conference on intelligent technologies and AI.
	Workshop	Machine Learning Techniques	Sidi Mohamed Ben Abdellah University, Fez	March 12-13, 2023	Practical workshops on machine learning techniques.
	Seminar	AI in Transportation	Hassan II University, Casablanca	April 30, 2023	Seminar on AI applications in the transportation sector.
	Webinar	AI and Cybersecurity	Cadi Ayyad University, Marrakech	September 8, 2023	Webinar on cybersecurity and AI.
2024	Conference	Conference on AI and Sustainable Development	Abdelmalek Essaâdi University, Tétouan	April 14-16, 2024	Conference on the impact of AI on sustainable development and innovation.
	Workshop	AI for Smart Cities	Hassan Ier University, Settat	July 10-11, 2024	Workshops on the application of AI to the management and development of smart cities.
	Seminar	AI in Healthcare Innovations	Mohammed V University, Rabat	May 5, 2024	Seminar on AI innovations in healthcare.
	Webinar	AI and Renewable Energy	University of Fez	June 20, 2024	Webinar on AI applications in the renewable energies sector.

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Appendix 4. Impacts of integrating AI into some aspects of Moroccan university governance:

Year	Project AI	Platform used	Expected results	Estimated digital achievements
2021	Chatbot for administrative services	IBM Watson	Reduce response time, improve efficiency	Response time reduced by 50%, student satisfaction increased by 30%.
	Registration management system	Microsoft Azure AI	Simplify registration processes, reduce errors	Registration process 2x faster, errors reduced by 40%.
2022	Predictive analysis of student performance	Google AI	Better identification of support needs	Prediction accuracy increased by 60%, success rate improved by 15%.
	Online course evaluation system	AWS AI Services	Improved educational quality, rapid feedback	Feedback 3x faster, teacher satisfaction increased by 25%.
2023	Optimization of library resources	Microsoft Azure AI	Efficient allocation of resources, cost reduction	Resource utilization increased by 50%, costs reduced by 20%.
	Admissions prediction system	TensorFlow	Improved admission rates, better planning	Prediction accuracy increased by 70%, acceptance rate improved by 10%.
2024	Development of a course recommendation system	TensorFlow	Personalized educational pathways	Course recommendations 90% more relevant, student engagement 20% higher
	Chatbot for student inquiries	IBM Watson	Reduce response time, improve efficiency	55% reduction in response time, 35% increase in student satisfaction

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