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Artificial Intelligence in Morocco: Current Situation and Recommendations

Intelligence artificielle au Maroc : Etat des lieux et recommandations

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Abstract

The article examines the progress and challenges of artificial intelligence (AI) in Morocco. The country has made significant advancements in the digital realm through investments in telecommunications infrastructure and programs like "Maroc Digital 2020." AI is being applied in various domains such as license plate recognition, traffic management, and satellite imagery for agriculture. AI technologies are also being used to optimize public transportation and for facial recognition in airports, thereby contributing to the security and efficiency of public services. However, ethical issues and concerns regarding privacy protection persist, particularly regarding the transparency and accountability of AI systems. In this article, adopting an analytical approach, we assess the current state of AI in Morocco by surveying the evolution of digitalization, then examining Morocco's positioning in the global AI landscape, subsequently highlighting pioneering AI projects and sectors in Morocco, and concluding with the challenges that remain following the advent of this technology. We conclude with recommendations for overcoming these challenges to ensure a responsible and beneficial adoption for society.

Keywords : Artificial intelligence, Morocco, current situation, recommandations.

Résumé :

L'article examine les progrès et les défis de l'intelligence artificielle (IA) au Maroc. Le pays a fait des avancées significatives en matière de numérique grâce à des investissements dans les infrastructures de télécommunications et des programmes comme "Maroc Digital 2020". L'IA est appliquée dans divers domaines tels que la reconnaissance de plaques d'immatriculation, la gestion du trafic et l'imagerie satellite pour l'agriculture. Des technologies d'IA sont également utilisées pour optimiser les transports en commun et pour la reconnaissance faciale dans les aéroports, contribuant ainsi à la sécurité et à l'efficacité des services publics. Toutefois, des enjeux éthiques et de protection de la vie privée subsistent, notamment en ce qui concerne la transparence et la responsabilité des systèmes d'IA. Dans cet article, en adoptant une approche analytique, nous faisons le point sur l'état actuel de l'IA au Maroc en survolant l'évolution du digital, puis en marquant le positionnement du Maroc dans le domaine de l'IA à l'échelle mondial, mettant ensuite l'accent sur les projets et secteurs pionniers de l'IA au Maroc pour finir par les défis qui subsistent suite à l'avènement de cette technologie. Nous concluons par des recommandations pour surmonter ces défis afin d'assurer une adoption responsable et bénéfique pour la société.

Mots clés : Intelligence artificielle, Maroc, état des lieux, recommandations.

Introduction

Morocco has made significant progress in the digital domain in recent years. With increasing investments in telecommunications infrastructure, access to high-speed internet has become more widespread across the country. For example, the National Plan for Telecommunications Infrastructure Development has improved network coverage and quality, thus facilitating access to digital services for a large portion of the population (Ministry of Industry, Trade, and the Green and Digital Economy, 2021). Additionally, the Moroccan government has implemented various programs aimed at promoting digital inclusion and encouraging the adoption of information and communication technologies. Among these initiatives is the "Maroc Digital 2020" program, which aims to enhance the digital capabilities of citizens and businesses, as well as improve e-government (Mohammed, 2023).

Meanwhile, artificial intelligence (AI) is also experiencing considerable growth in Morocco, with applications in areas such as image processing, voice recognition, and text processing (Jeldi, 2022). AI technologies are used in license plate recognition radars, traffic management cameras, satellite imagery for agriculture, public transportation organization, and facial recognition in airports. For example, intelligent radars used for license plate recognition enable more efficient traffic management and contribute to road safety.

However, the development of AI raises significant issues in terms of human rights and ethics, particularly concerning transparency, accountability, privacy, and algorithmic biases (INPPLC, 2022). Morocco must pave the way for AI adoption by building skills, establishing appropriate legal frameworks, and ensuring users' digital trust (Jeldi, 2022). Data protection, in particular, is a major concern, and efforts must be made to align Moroccan practices with international standards such as the GDPR in Europe (CNDP, 2016). Additionally, it is essential to raise public awareness about the benefits and risks of AI to ensure informed and responsible adoption.

Using an analytical methodology, this article will begin by tracing the evolution of digitalization in Morocco, then delve into Morocco's global positioning in the field of AI, focusing on pioneering AI projects in various sectors, and finally, dissect the challenges and issues related to artificial intelligence in the Moroccan context.

1. Evolution of the Digital Landscape in Morocco

Over the past decades, Morocco has demonstrated a steadfast commitment to positioning itself as a leader in information and communication technologies in Africa. Initiated in 1995 with the liberalization of internet access, this ambition has translated into a series of reforms and strategic programs aimed at modernizing technological infrastructure and fostering digital innovation (Rabhi and Belfhaili, 2023). From the introduction of the first connectivity policies to the establishment of dedicated institutional frameworks such as the Digital Development Agency, each significant step in this evolution reflects Morocco's commitment to inclusive and sustainable digital transformation. This document traces the chronological evolution of major digital initiatives in Morocco, highlighting the kingdom's continuous efforts to integrate digital technologies into all aspects of society and the economy.

Table N° 1: Evolution of the digital in Morocco

Year	Details
1995	**Introduction of the Internet** Morocco has consistently proven its commitment to adopting and promoting technological advancements. In 1995, Morocco introduced a liberalization policy and established its first Internet connection, enabling Internet access for its citizens.
1996	**'Competitive Morocco' program** A year later, in 1996, the kingdom launched the 'Competitive Morocco' program dedicated to improving national competitiveness in the information technology (IT) sector.
1998	**Creation of the State Secretariat for Telecoms & IT, and the ANRT** In 1998, a State Secretariat reporting to the Prime Minister was established for the first time in Morocco, responsible for Postal and Telecommunications and Information Technology. The same year, the National Telecommunications

Year	Details
	Regulatory Agency (ANRT) was created to regulate and control the telecommunications sector.
2001	**E-Morocco: first national digital strategy** In 2001, Morocco launched its first National Digital Strategy, called 'e-Morocco', aimed at modernizing the public administration and promoting the development of e-commerce. This program was followed by 'e-Morocco 2010' in 2005, which aimed to make the kingdom a regional leader in IT and promote the use of technology in all sectors.
2008	**'Digital Morocco 2013' program** In 2008, the 'Digital Morocco 2013' program was launched to support the development of the digital economy and promote innovation and entrepreneurship.
2009	**Creation of the CNDP** In 2009, the National Commission for the Control of Personal Data Protection (CNDP) was established.
2011	**Creation of the DGSSI** The creation of the General Directorate of Information Systems Security (DGSSI) in 2011.
2016	**'Digital Morocco 2020' initiative** In 2016, the 'Digital Morocco 2020' initiative was launched to complement the achievements of 'Digital Morocco 2013'.
2017	**Creation of the ADD** The creation of the Digital Development Agency (ADD) in 2017.

Year	Details
2021	**Ministry of Digital Transition** The establishment of a dedicated Ministry of Digital Transition in 2021.

Source: Own construction

2. Morocco's Positioning in the Global AI Landscape

In terms of AI development and adoption, Morocco has made notable progress primarily through the creation of academic institutions, international conferences, effective training and education programs, and the establishment of large-scale data centers. Recognizing these initiatives is undoubtedly important, and they should be expanded and replicated for further progress. However, the objective here is to position Morocco in the global AI landscape.

The methodology of this chapter adopts a global approach based on internationally recognized measures and benchmarks. This allows us to assess Morocco's progress in AI, identify areas needing further development, and determine its position on the international stage as a significant player in the AI domain. Various benchmarking tools are available to assess countries' AI readiness. We examined three of the most robust methodologies: the Global AI Index by Tortoise, the Government AI Readiness Index by Oxford Insights, and the Scimago Journal Ranking. Our analysis aims to evaluate the state of AI in Morocco based on essential factors driving AI advancements.

These rankings are adapted from the MoroccoAI report on recommendations for a national AI strategy in Morocco.

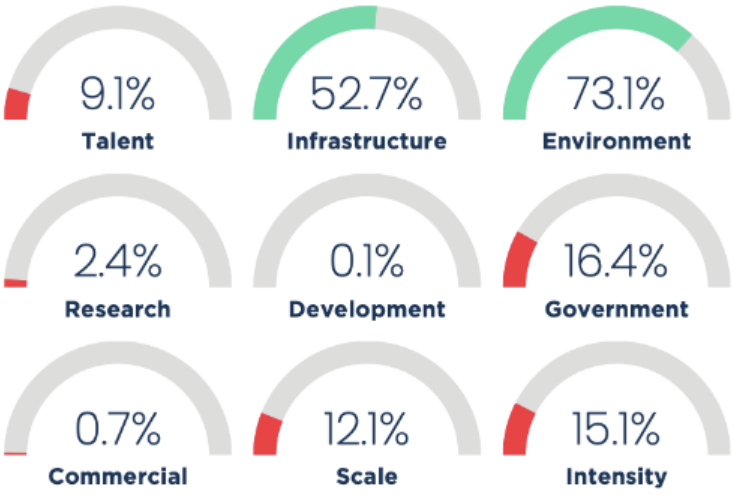
2.1. Global AI Index

The Global AI Index is a crucial tool for evaluating governments' ability to integrate and regulate AI within their countries. It emerged from an independent initiative by the Stanford Institute for Human-Centered Artificial Intelligence (HAI). This index is conducted by Tortoise Media, a British media company founded in 2018 by James Harding, former director of BBC News and editor of The Times. Tortoise Media launched this index in 2019. The index uses a set of 111 indicators from 28 public and private sources to assess AI investment, innovation, and implementation levels in 62 countries. The indicators are grouped into seven sub-pillars: Talent, Infrastructure, Operating Environment, Research, Development, Government Strategy,

and Commercialization. Additionally, the global index includes two other parameters: scale, which measures a nation's absolute AI capacity, and intensity, which evaluates AI capacity relative to the population or economy size.

According to this index, Morocco ranks well in terms of infrastructure, being 57th globally and 1st in Africa. This infrastructure includes consistent power supply and broadband connectivity in cities, small towns, and rural areas, while more advanced infrastructures include supercomputing capabilities. Moreover, Morocco holds a favorable position in its operating environment, ranking second in Africa, just after South Africa. This operating environment considers aspects such as trust in AI and the diversity of practitioners facilitating AI development. However, other parameters such as talent, research, and development require additional efforts to achieve a stronger positioning.

Figure 1: Components of the "Global AI Index" - Case of Morocco



Source : Stanford Institute for Human-Centered AI-HAI 2022

2.2. Government AI Readiness Index

The second tool used in the Morocco AI report to evaluate Morocco's AI readiness is the Government AI Readiness Index. This index focuses on assessing governments' preparedness to implement AI in public service delivery to their citizens.

The Government AI Readiness Index, conducted by Oxford Insights since 2017, evaluates 193 countries using 39 indicators across three main pillars: Government, Technology Sector, and Data & Infrastructure.

Government: This pillar assesses national AI policies and strategies, government commitment to technological innovation, and AI regulation. Indicators include the presence of national AI strategies, regulatory frameworks, and ethical governance initiatives.

Technology Sector: This pillar examines the robustness of a country's technology sector, including levels of research and development (R&D), AI investments, and the quality of technological infrastructure. It also evaluates public-private collaboration in the AI domain.

Data & Infrastructure: This pillar analyzes the availability and quality of data and the infrastructure necessary to support AI. Indicators include internet connectivity, open data availability, and data storage and processing capacity.

These indicators cover ten dimensions, providing a detailed view of each country's strengths and weaknesses in AI readiness.

The index's goal is to provide policymakers, researchers, and stakeholders with a tool to understand where countries stand in terms of AI readiness and which areas require particular attention. Additionally, the index aims to encourage international collaboration and share best practices to overcome common challenges related to AI adoption.

In terms of this index, the leading countries are the United States, Singapore, and the United Kingdom, as the most prepared nations to implement AI in the public sector.

Morocco ranks 87th globally and 5th in Africa, following Mauritius, Egypt, South Africa, and Tunisia. Notably, Mauritius and Egypt have already established national AI strategies, while Tunisia has announced the development of its AI strategy.

2.3. Scimago Journal & Country Rank

A third index used for evaluation, with a particular focus on research, which constitutes the fundamental pillar of innovation and advancement in AI. The Scimago Journal & Country Rank (SJR) is an indicator that measures the scientific impact of journals and countries in various research fields, including AI. This index takes into account the number of citations received by publications, the impact of journals where articles are published, and other bibliometric metrics.

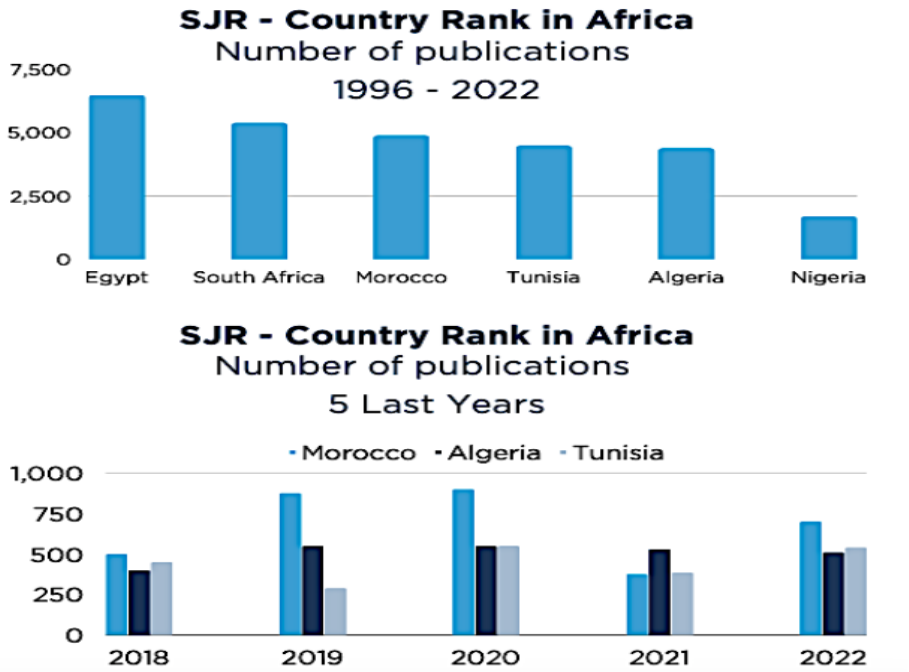
The SJR, conducted by the SCImago Research Group, an organization that analyzes publication and scientific impact trends globally, uses data from the Scopus database, one of the largest abstract and citation databases of scientific literature. Since its launch in 2004, the SJR ranks journals and countries based on their scientific output and impact. It considers the quality and

reputation of journals where articles are published, as well as the number of citations received by these publications. By combining these criteria, the SJR offers a detailed and comparative evaluation of the scientific impact of various entities, facilitating the understanding of research dynamics globally (SCImago Research Group).

According to this index, Morocco has produced over 4,500 publications in AI between 1996 and 2022, placing it among the top three leading countries in AI research in Africa, following Egypt and South Africa. Algeria, Tunisia, and Nigeria followed with 4,401, 4,301, and 1,788 AI-related publications, respectively, over this period.

It is important to note that this comparison in terms of research is not comprehensive as it solely relies on the number of publications as an indicator, without integrating other crucial metrics such as citations and the H-index. This research-based approach is merely suggestive and requires the integration of various additional metrics for a thorough and holistic comparison.

Figure 2 : Number of AI publications



Source: Scimago Journal Rank – 2022

3. Pioneering AI Projects and Sectors in Morocco

AI is gaining momentum in Morocco, catalyzing an unprecedented technological revolution across various sectors. According to McKinsey & Company, AI represents a significant

Artificial intelligence is gaining momentum in Morocco, catalyzing an unprecedented technological revolution across various sectors. According to McKinsey & Company, AI represents a significant opportunity for Morocco. In its study "Digital and Artificial Intelligence Potential," published in 2018, the firm declared that there are currently eight sectors mature enough to fully benefit from these technologies: banking, telecommunications, insurance, automotive industry, agriculture, energy, entrepreneurship, and e-government.

Financial and Banking Sector In Morocco, the emergence of AI-based solutions aims to enhance financial services, ranging from customer relationship management to transaction security. From startups to large financial institutions, AI is redefining Moroccan financial practices. A study on AI and big data adoption in Moroccan enterprises conducted by Boushaba and Chakour in 2023 revealed that companies in the financial sector were more likely to utilize AI than other sectors due to significant benefits in forecasting and risk analysis. There is a growing trend towards adoption. Furthermore, Moroccan banks, in particular, are beginning to embrace AI to enhance their services. Guerra (2021) stated in an article that several Moroccan banks have implemented chatbots and virtual assistants to address customer inquiries, reduce waiting times, and enhance the growing customer experience. AI is also used to detect fraud and suspicious activities in corporate financial transactions. Begil et al. (2021) emphasize in their book that AI can help identify suspicious behaviors in financial transactions, thereby helping companies reduce the risk of fraud.

BankTech AI A project initiated by the Central Bank of Morocco in partnership with local fintechs, designed to integrate AI into fraud detection and credit analysis. This initiative transforms the way financial institutions assess risks and interact with their clients.

Digital Health AI is revolutionizing the healthcare sector in Morocco, with various applications ranging from AI-assisted medical diagnosis to optimizing hospital management, making healthcare more accessible and effective.

MediAI Solutions A collaboration between the Ministry of Health and a Moroccan startup, developing AI tools to improve the diagnosis of chronic diseases. The project has been tested

in several hospitals in Casablanca and has shown promising results in terms of efficiency and diagnostic accuracy.

Smart Agriculture In a country where agriculture is crucial, AI offers solutions for optimal crop management and sustainable resource use through advanced systems for monitoring and analyzing environmental data.

Mobile Plant Recognition Application Developed by researchers at Sidi Mohammed Ben Abdellah University in Fes, this mobile application uses AI to identify plants from photos. This application helps farmers identify crops and crop diseases.

Air Quality Monitoring Project Developed by the Moroccan company WISE AI, the project uses AI to monitor air quality in Moroccan cities. The system uses air quality sensors and surveillance cameras powered by AI algorithms to measure real-time air quality and alert authorities in case of pollution.

AgriSmart A platform that uses AI to provide accurate weather forecasts and tailored farming advice to farmers in the Atlas region. This system contributes to optimal water management and increased yields, supporting the sustainability of Moroccan agriculture.

Education and Training The adoption of AI in Moroccan educational systems aims to personalize teaching and improve educational performance, making learning more interactive and tailored to the individual needs of students.

EduAI An initiative that adapts learning in Moroccan schools through AI tools. EduAI assesses student performance to offer personalized educational paths, thus improving engagement and academic performance.

Smart Tourism Morocco utilizes AI to enhance the tourist experience, from personalized offerings to intelligent management of tourist sites, strengthening its appeal as a destination of choice.

Morocco Explorer AI A project developed by the Moroccan National Tourism Office, which offers a mobile AI-based application providing personalized itineraries to tourists based on their preferences and visit history in the country. The application aims to enrich visitor experiences and promote sustainable tourism.

4. Challenges and opportunities of AI in Morocco

The challenges related to artificial intelligence (AI) in Morocco are numerous and require a meticulous strategy to promote ethical and efficient development of this technology. Here are the main challenges identified:

4.1. Regulatory and legal framework:

It is essential to establish an appropriate legal framework to regulate the use of AI, protect personal data, ensure cybersecurity, and maintain Morocco's digital sovereignty (Jeldi, 2022). In this sense, Morocco has already put in place and continues to put in place laws and institutions to frame the subject. We cite:

Law No. 09-08 on the protection of individuals with regard to the processing of personal data. This law established the National Commission for the Control of Personal Data Protection (CNDP), which ensures that AI practices respect the right to privacy and individual freedoms (CNDP).

Law No. 07-03 amending the Penal Code to include provisions on computer crimes.

Law No. 53-05 on the electronic exchange of legal data.

National Cybersecurity Strategy: Established by the Directorate General of Information Systems Security (DGSSI), this strategy aims to protect information systems against cyberattacks and strengthen digital trust (DGSSI, 2011).

Digital Development Agency (ADD): Created to promote the development and use of digital technologies, including AI, and raise awareness of the challenges of digital transformation (ADD, 2022).

New Development Model (NMD): Emphasizes digital transformation as a catalyst for economic growth and social inclusion (NMD, 2021).

Despite this, Morocco has not yet formulated a national artificial intelligence strategy, unlike African countries such as Mauritania and Egypt. However, this technology poses many challenges that will lead to constant evolution of regulations, particularly with regard to the ethical issues raised by this technology, further exacerbated by the inherent problems in regulating algorithms, which remain difficult due to the evolving nature of the technology and the confidential and competitive nature of developments. In this regard, the development of a Moroccan strategy specific to artificial intelligence, aimed at putting this technology at the

service of citizens while stimulating the country's competitiveness in this field, is essential (Jeldi,2022).

4.2. Skill development

The proper training of skills is a major challenge for the successful digital transformation associated with AI in various sectors in Morocco (MAA, 2023).
The Moroccan government has put in place several initiatives to develop the necessary skills to cope with the expansion of AI in the country.

University programs and continuing education• Several Moroccan universities have integrated training programs in artificial intelligence and data science. For example, the Mohammed VI Polytechnic University (UM6P) offers specialized courses in AI, with international partnerships to ensure high-quality training (Université Mohammed VI Polytechnique).
• Institutions like the National Higher School of Computer Science and Systems Analysis (ENSIAS) offer master's and doctoral programs focused on AI and emerging technoogies.

Government initiative:

The "Digital Morocco 2020" program includes components dedicated to training and strengthening digital skills, aimed at preparing the Moroccan workforce for the challenges of AI(Mohammed,2023).
• The Digital Development Agency (ADD) regularly organizes training and workshops on AI and digital technologies, in collaboration with national and international experts (ADD, 2022).

Public-Private Partnerships:
• Morocco encourages partnerships between the public sector, private companies, and academic institutions to create AI training programs. For example, companies like IBM and Microsoft collaborate with Moroccan universities to offer specialized certifications and training .

4.3. Protection of Fundamental Freedoms and Rights:

The development of AI must be balanced to avoid infringements on fundamental freedoms and rights, while maximizing the benefits of the technology (Akkour et al., 2023). Although artificial intelligence (AI) represents a major technological advancement, it raises crucial questions about its impact on fundamental freedoms and rights. According to Salil Shetty, former Secretary General of Amnesty International, "there are immense possibilities and

benefits to be reaped from artificial intelligence if human rights are at the heart of this technology."Artificial intelligence is considered one of the most advanced technologies of our time. However, it also raises concerns about its impact on fundamental freedoms and rights. On the one hand, the use of AI can lead to increased surveillance of the population. AI systems can be used to track online activities and physical movements of individuals, which can infringe on privacy. Moreover, facial recognition algorithms can be used to identify people in public places, which can also be considered a violation of privacy.On the other hand, AI can also impede freedom of expression. Some companies use algorithms to censor controversial opinions and political views, which can restrict individuals' ability to express themselves freely on social media. Additionally, AI can have a negative impact on employment. Automated systems can replace human workers, which can result in job loss and reduced wages for the remaining workers. This can also affect the economic and social rights of workers. Finally, AI can also lead to systemic discrimination. Algorithms can be biased due to the training data used to develop them, which can result in discrimination against minority groups.

4.4. Data Security and Confidentiality:

In many countries, measures to protect personal data from AI are addressed within the framework of existing legislation on privacy and personal data protection. Additionally, data protection laws have agreed to maintain the current principles of data protection. In Morocco, the protection of personal data against AI refers to the general regulations concerning the protection of natural persons with regard to the processing of personal data. This regulation offers an attractive domain for research and innovation in various fields, thus justifying the development of prospective law.

The current regulation focuses on individual interests and fundamental rights such as privacy and data protection, which are based on the concept of "personal data" allowing the identification or characterization of a natural person. However, the processes related to AI are not limited to the management and processing of data at an individual level, but also encompass the increasing use of aggregated data, general profiles, and group profiles. It is therefore necessary to question whether the focus on the individual and personal data remains relevant in the AI era.

Statistical correlations and group profiles are not considered personal data, but can nevertheless be used to widely influence the living context of individuals. Moreover, the development of the

use of Big Data through AI raises questions about the very definition of what is considered personal data.

It is therefore crucial for Morocco to adopt appropriate and up-to-date regulations to ensure the security and confidentiality of data processed by AI systems. (Akkour et al., 2023).

Conclusion

In summary, Morocco has made remarkable progress in the field of information and communication technologies, positioning itself as a leader in Africa. The reforms and strategic programs put in place reflect a strong commitment to inclusive and sustainable digital transformation. Challenges remain numerous, but with continued efforts and a clear strategic vision, Morocco is well-positioned to fully integrate digital technologies into its economic and social development.

Morocco has made significant progress in adopting AI in various sectors, but additional efforts are needed to overcome existing challenges and fully harness the potential of this technology for the country's economic and social development.

The integration of AI in our societies must be managed with particular attention to human rights. It is imperative that developments in this area be accompanied by policies that guarantee not only technological innovation but also the protection of fundamental rights.

It is in this momentum that we bring a number of recommendations that Morocco could consider to address the challenges posed by this disruptive technology of artificial intelligence:

1. Strengthening Research and Development (R&D):
   It is essential to strengthen AI research capabilities through dedicated funding and the creation of centers of excellence. These centers should focus on local applications of AI, such as smart agriculture, water management, and digital health.
2. Awareness and Digital Education:
   Awareness campaigns must be launched to educate the general public on the benefits and risks of AI. This includes integrating educational modules on AI into school curricula from the primary and secondary levels.
3. Innovation Ecosystem:
   The development of a strong innovation ecosystem is crucial. This includes the creation of technology hubs and AI-specialized startups, supported by incubators and business accelerators.

4. Regulatory and Ethical Framework:

   Morocco must also continue to develop a clear and ethical regulatory framework for the use of AI. This includes the protection of personal data, the transparency of algorithms, and the fight against algorithmic biases (INPPLC, 2022).

5. Infrastructure:

   It is crucial to strengthen technological infrastructure, including data centers and communication networks, to support large-scale AI applications.

6. Regulatory Framework:

   The development of a clear and precise legal framework is necessary to regulate the use of AI, protect personal data, and ensure the transparency of algorithms (CNDP, 2020).

7. Skills and Training:

   It is essential to continue investing in the training of AI talents, by offering specialized educational programs and promoting research and innovation in this field.

In conclusion, to fully harness the potential of artificial intelligence in Morocco's economic and social development, it is imperative to overcome these challenges by establishing effective regulatory policies, training specialized talents, and ensuring ethical and responsible use of this technology.

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