

Artificial Intelligence in Libyan Industries: Current State and Future Prospects

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ABSTRACT

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This paper critically examines the role and future of Artificial Intelligence (AI) in the industrial sectors of Libya, offering an in-depth analysis of its current adoption, potential growth, and the consequent impacts on the country's economic and technological landscape. Beginning with a global perspective, the study traces the evolution of AI from its foundational stages to its current status as a key driver of innovation and efficiency in diverse sectors globally. It then narrows its focus to Libya, where the industrial scene is predominantly anchored in the oil and gas sector, exploring how AI is beginning to shape these fields, as well as its emerging presence in manufacturing and agriculture. The analysis acknowledges the unique challenges Libya faces in terms of technological infrastructure and educational readiness for a future shaped by AI. By drawing parallels with similar economies, the study identifies strategic lessons and approaches that could facilitate AI integration in Libya. It forecasts significant growth and diversification of AI applications across Libyan industries, emphasizing the necessity of comprehensive government policies, educational reform, and international collaborations to enable this transition. Conclusively, the paper posits that AI is not merely a technological upgrade but a strategic asset for Libya's economic diversification and technological advancement. It argues for a balanced approach that encompasses ethical considerations and regulatory frameworks to fully leverage AI's capabilities. This comprehensive exploration underscores AI's potential as a transformative force for Libya's industrial sectors, highlighting its pivotal role in shaping the nation's economic resilience and technological progress in the digital era.

1 Introduction

Artificial Intelligence (AI) has evolved from a nascent technological concept into a pivotal force reshaping global industries and societies. As highlighted by Schwalbe and Wahl (2020), AI's impact on global health demonstrates its expansive influence. This evolution, marked by milestones from machine learning to deep learning, has been documented in the works of Zhao, Blaabjerg, and Wang (2020). The global landscape of AI is diverse, with varying levels of adoption and innovation across different regions, as illustrated by Jaldi (2023) in his examination of the AI revolution in Africa. AI's significance in the industrial sector is profound, driving efficiency, innovation, and competitiveness. It enhances productivity and quality, as demonstrated in various sectors from transportation (Abduljabbar et al., 2019) to power electronics (Zhao et al., 2020). AI's role in fostering environmental sustainability and worker safety further underscores its multifaceted impact. This transformative influence is not limited to traditional industries but extends to sectors like healthcare and agriculture, where AI-driven innovations are creating new paradigms (Tran et al., 2019; Kakani et al., 2020).

Libya's industrial landscape, dominated by the oil and gas sector, plays a significant role in its economy. This sector's potential for AI integration, as discussed by Sircar et al. (2021), opens avenues for enhanced efficiency and innovation. Beyond oil and gas, Libya's industries like manufacturing and construction are in a developmental phase, presenting opportunities for AI-driven transformation. Post-conflict reconstruction efforts, as noted by Oun, Benabdallah, and Cherif (2019), offer a unique opportunity to integrate AI technologies into the rebuilding process. This paper posits that while the current state of AI in Libyan industries is embryonic, the potential for its future integration is substantial. The integration of AI technologies in Libya's dominant and emerging sectors presents an opportunity to enhance efficiency, foster economic diversification, and drive sustainable development. By analyzing the current landscape and predicting future trends, this paper aims to provide insights into how AI can be strategically leveraged to transform Libya's industrial sectors and contribute to its long-term economic growth.

2 Background

The development of Artificial Intelligence (AI) has been a global endeavor, marked by significant milestones and evolving paradigms. Initially conceptualized in the mid-20th century, the field has seen rapid advancement over the decades. The foundational period, as outlined by Makhluaf and Abdulshahed (2020), focused on establishing the theoretical underpinnings of AI, with early research concentrated on symbolic AI and logic-

based approaches. The transition to machine learning, particularly in the 1980s and 1990s, marked a significant shift in AI development. This period saw the emergence of algorithms capable of learning from data, as highlighted by Necula (2023), setting the stage for more advanced applications of AI. The advent of deep learning in the 21st century, as discussed by Rekkas et al. (2021), further revolutionized the field, enabling breakthroughs in natural language processing and computer vision.

Throughout its history, AI has been characterized by cycles of progress and stagnation, often referred to as 'AI winters.' Despite these challenges, the field has consistently advanced, driven by improvements in computational power and data availability.

2.1 Overview of Libyan industries

Libya's industrial landscape is diverse yet predominantly centered on the oil and gas sector. This sector plays a critical role in the national economy, as Sircar et al. (2021) illustrate, highlighting its contribution to GDP and export revenue. However, the reliance on oil and gas also poses challenges, necessitating economic diversification. Beyond petroleum, industries like manufacturing, agriculture, and construction are integral to Libya's economy, though they remain less developed compared to the oil and gas sector. The construction industry, in particular, is crucial in the context of Libya's post-conflict rebuilding efforts, as indicated by Elmousalami (2020) in his discussion on AI in construction cost estimation. Agriculture, while not the primary driver of the economy, is vital for food security and rural livelihoods. The potential for technological integration in this sector, including the use of AI for sustainable practices, remains largely untapped.

2.2 Current technological infrastructure in Libya.

Libya's technological infrastructure is evolving, with significant room for growth and modernization. The post-conflict era presents both challenges and opportunities in rebuilding and enhancing technological capabilities. Ahmed et al. (2023) emphasize the importance of developing smart infrastructure, including the adoption of AI and IoT technologies, in the context of smart homes and cities.

Despite the potential, the country faces hurdles, including limited access to advanced technologies and a shortage of skilled professionals in the AI domain. The education and training systems, therefore, play a crucial role in preparing the workforce for a more technologically advanced future, as discussed by Alzahrani (2022) in the context of AI in education. In summary, Libya's industrial and technological landscape is at a pivotal point, with significant potential for leveraging AI to drive growth and modernization. This background sets the stage for a deeper exploration of the current state and future prospects of AI in Libyan industries.

3 Current State of AI in Libyan Industries

3.1 Overview of AI adoption in Libyan industries.

The adoption of Artificial Intelligence (AI) in Libyan industries is in its early stages, characterized by a gradual yet significant interest in various sectors. This adoption, influenced by the country's recent history and economic landscape, varies across different industries. The oil and gas sector, as detailed by Sircar et al. (2021), is at the forefront of incorporating AI, driven by the need to enhance efficiency and optimize resource management. Other sectors, such as manufacturing and agriculture, are gradually recognizing the potential of AI but are still in the initial phases of adoption.

3.2 Case studies/examples of AI applications in key sectors

Oil and Gas: The Libyan oil and gas industry has begun to explore AI for optimizing operations. Applications include predictive maintenance, data analysis for exploration, and automation, as highlighted by Sircar et al. (2021). These AI-driven solutions are geared towards enhancing production efficiency and minimizing downtime.

Manufacturing: In manufacturing, AI's role is still emerging. Potential applications observed in similar contexts globally, such as in the work of Kakani et al. (2020), include quality control, supply chain optimization, and predictive maintenance. While not yet widespread in Libya, these applications offer a blueprint for future integration.

Agriculture: Agriculture in Libya could benefit significantly from AI in areas like crop monitoring and pest control, similar to the advancements discussed by Kakani et al. (2020). Though in its infancy, such technology has the potential to revolutionize agricultural productivity in Libya.

3.3 Benefits observed from AI integration.

Despite its nascent stage, AI integration in Libyan industries has demonstrated several benefits:

- **Operational Efficiency:** Particularly in the oil and gas sector, AI has led to more efficient operational processes, as evidenced by the findings of Sircar et al.(2021) .
- **Cost Savings:** Automation and predictive maintenance facilitated by AI have shown potential for reducing operational costs.
- **Enhanced Decision Making:** AI's ability to process vast amounts of data has enabled better-informed decision-making, a critical factor in industries such as oil and gas and manufacturing.

3.4 Challenges and limitations faced

The path to widespread AI adoption in Libya is fraught with challenges:

- **Technological Infrastructure:** As Ahmed et al. (2023) note, the limited technological infrastructure in Libya is a significant barrier to AI integration.
- **Financial Constraints:** The financial investment required for AI adoption is substantial, a challenging prospect in Libya's current economic climate.
- **Educational and Skills Gap:** There's a notable gap in AI-related skills within the workforce, as discussed by Alzahrani (2022). This gap hinders the development and implementation of AI technologies.
- **Policy and Regulatory Frameworks:** The lack of specific regulatory and policy frameworks for AI, a concern echoed by Zekos (2021), poses challenges in terms of ethical adoption and integration.

In conclusion, while the current state of AI in Libyan industries is in its formative stages, there are clear indicators of its potential impact, particularly in sectors like oil and gas. Overcoming the challenges of infrastructure, investment, skill development, and regulatory frameworks is essential for Libya to fully leverage AI's capabilities for industrial growth and innovation.

4 Impact Analysis

4.1 Economic impact of AI on Libyan industries.

The economic impact of Artificial Intelligence (AI) in Libyan industries is expected to be substantial, especially in key sectors like oil and gas. As indicated by Sircar et al. (2021), AI's role in optimizing operations can lead to enhanced productivity and cost-efficiency, potentially boosting the overall economic output. The integration of AI can also stimulate growth in other sectors, such as manufacturing and agriculture, where AI-driven innovations could lead to new business models and market opportunities, similar to the trends observed globally in studies like those of Kakani et al.(2020) .

Furthermore, AI's potential in driving economic diversification is crucial for Libya. By reducing the over-reliance on the oil and gas sector and promoting growth in other industries through AI, Libya can achieve a more balanced and resilient economy. This diversification is vital in creating a stable economic environment, attracting foreign investments, and fostering sustainable economic development.

4.2 Social implications

The social implications of AI in Libya's industries are profound, particularly in terms of employment and skill development. While AI may automate certain tasks, potentially impacting jobs, it also creates new employment opportunities in areas like AI maintenance, data analysis, and system management. This shift necessitates a focus on re-skilling and up-skilling the workforce, as highlighted by Alzahrani (2022), to prepare for the demands of an AI-driven economy.

Moreover, AI's integration into education, as discussed by Gadhoum (2022), is essential in fostering a workforce adept in AI and related technologies. Investing in STEM education and specialized AI programs can help Libya build a pool of skilled professionals, driving innovation and supporting the country's industrial growth.

4.3 Environmental considerations

The environmental implications of AI in Libyan industries are increasingly important. AI can significantly contribute to sustainable practices, particularly in energy-intensive sectors like oil and gas. For instance, AI applications in energy efficiency and waste reduction can mitigate environmental impacts, aligning with global sustainability goals. In the context of environmental management, Miskat et al. (2023) discuss AI's role in

integrating sustainable practices, such as in solar energy applications, which could be relevant for Libya's growing renewable energy sector.

Additionally, AI can aid in environmental monitoring and conservation efforts. Using AI for data analysis and predictive modeling can help address environmental challenges, such as pollution control and resource management. This application is crucial for Libya, considering its unique environmental concerns and the need for sustainable industrial practices. In conclusion, the impact of AI on Libyan industries encompasses economic growth, social transformation, and environmental sustainability. The successful integration of AI holds the potential to transform Libya's economy, create new job opportunities, enhance skill development, and promote environmentally sustainable practices. As Libya continues to navigate its path towards economic diversification and modernization, AI stands out as a key enabler for a more prosperous and sustainable future.

5 Comparative Analysis

5.1 Compare AI integration in Libya with other similar economies

When examining the integration of Artificial Intelligence (AI) in Libya in comparison to similar economies, especially those within the Middle East and North Africa (MENA) region and other oil-dependent countries, several key differences and similarities can be identified:

- **Stage of AI Adoption:** Libya's early stages of AI adoption present a contrast to countries like Saudi Arabia or the UAE. These nations have advanced AI integration across various sectors, as seen in the comprehensive approach to AI in education discussed by Alzahrani (2022) and the advanced AI applications in industries as highlighted by Sircar et al.(2021) .
- **Government Initiatives and Policies:** Libya's approach to AI integration lacks the structured national strategies seen in some of its regional counterparts. For example, countries like the UAE have dedicated national AI strategies, indicating a more systematic and policy-driven approach to AI adoption.
- **Focus on Diversification:** Unlike Libya, where AI's primary focus is on the oil and gas sector, other similar economies have diversified AI applications into sectors like healthcare, as indicated by the work of Taha-Mehlitz, Hendie, and Taha (2021), and renewable energy, as discussed by Singh et al. (2022).

5.2 Lessons learned from other countries' experiences

Libya can glean several lessons from the AI integration experiences of other countries:

- **Development of National AI Strategies:** As seen in the UAE and Saudi Arabia, the creation of national AI strategies can provide a coherent framework for AI development across sectors, ensuring ethical and efficient implementation, as noted by Alzahrani(2022) .
- **Economic Diversification through AI:** The experiences of other oil-dependent countries show the importance of using AI for economic diversification. For instance, the application of AI in renewable energy, as discussed by Singh et al. (2022), demonstrates the potential for AI to support sustainable economic growth beyond the primary industry.
- **Investment in AI-Related Education and Training:** The success of AI in other economies highlights the need for substantial investment in education and training. The focus on AI in education, as exemplified by Alzahrani (2022), is crucial in developing a skilled workforce capable of supporting AI initiatives.
- **Building Public-Private Partnerships:** Learning from countries where public-private partnerships have accelerated AI adoption, Libya can facilitate collaborations between government entities and private sectors. These partnerships can bring expertise, technology, and investment, as evidenced in more advanced AI-integrated economies.
- **Establishing Ethical and Regulatory Frameworks:** The importance of ethical guidelines and regulatory frameworks in AI, as discussed in the work of Zekos (2021), is critical. Libya can benefit from establishing such frameworks to ensure responsible and beneficial AI deployment.

In conclusion, Libya's path to AI integration can be informed by the experiences of other similar economies. Understanding these comparative dynamics can help Libya develop effective strategies for AI adoption, focusing on diversification, education, infrastructure, public-private partnerships, and ethical regulations. This comparative analysis is vital for Libya to leverage AI for sustainable economic growth and technological innovation.

6 Future Prospects and Potential

6.1 Predictions for AI growth in Libyan industries

The future trajectory of Artificial Intelligence (AI) in Libyan industries is expected to be marked by substantial growth and diversification. Building upon the initial steps in the oil and gas sector, as Sircar et al. (2021) suggest, the use of AI is likely to become more sophisticated, incorporating advanced predictive analytics and automation. This progression aligns with global AI trends in energy sectors, where AI significantly enhances operational efficiency and decision-making.

Beyond the energy sector, AI is poised to make inroads into other key industries. Manufacturing could see the integration of AI in process optimization and quality control, reflecting global advancements in AI applications in manufacturing (Kakani et al., 2020). In agriculture, AI technologies for crop monitoring and yield prediction could revolutionize farming practices, similar to advancements seen in other countries.

The healthcare sector in Libya could also benefit from AI, with potential applications in diagnostics and patient care management, as indicated by the works of Taha-Mehlitz, Hendie, and Taha (2021). These AI-driven innovations could significantly improve healthcare delivery and outcomes.

6.2 Emerging AI technologies relevant to Libya's industrial sectors

Libya's industrial sectors could benefit from several emerging AI technologies:

- **Advanced Data Analytics in Oil and Gas:** Enhanced data analytics for predictive maintenance and exploration could revolutionize the oil and gas sector, as discussed by Sircar et al. (2021).
- **Machine Learning in Manufacturing and Agriculture:** Leveraging machine learning for improving manufacturing processes and agricultural productivity could mirror the successes seen in studies like those of Kakani et al. (2020).
- **Healthcare AI:** AI applications in healthcare, from diagnostics to treatment planning, could align with global healthcare trends, as observed by Taha-Mehlitz, Hendie, and Taha (2021).

6.3 Potential strategies for enhancing AI adoption and overcoming challenges.

To effectively enhance AI adoption in Libya, several strategies can be employed:

- **Infrastructure Development:** Building robust technological infrastructure is crucial for supporting AI technologies, a need that is echoed by Ahmed et al. (2023) in their discussion on smart cities.
- **Education and Skill Development:** Investing in education and training programs, as highlighted by Alzahrani (2022), is essential for creating a skilled workforce capable of working with AI technologies.
- **Government Policy and Support:** Developing government policies and incentives for AI research and adoption can stimulate growth in this area. This approach can be informed by the experiences of other countries in the MENA region.
- **Collaboration and Partnerships:** Encouraging public-private partnerships can bring in necessary expertise and investment, as seen in other economies with successful AI integration.
- **Regulatory Frameworks:** Establishing clear regulatory frameworks for AI, as suggested by Zekos (2021), is crucial for ensuring ethical and effective implementation.

In conclusion, the potential for AI in Libyan industries is significant, with opportunities spanning various sectors. By focusing on infrastructure development, education, policy support, collaborations, and regulatory frameworks, Libya can harness AI's capabilities to drive industrial innovation and support its economic growth and diversification.

7 Recommendations

7.1 Government policies and initiatives to support AI growth

To catalyze AI growth in Libya, government involvement is crucial. Key recommendations include:

- **Development of a National AI Strategy:** Similar to strategies in advanced AI nations, Libya should establish a comprehensive AI strategy. This could involve setting benchmarks, defining ethical guidelines, and aligning AI development with national priorities, akin to the strategies seen in countries like the UAE, as mentioned by Alzahrani (2022).
- **R&D Funding and Incentives:** Substantially increase funding and incentives for AI research and development. This could involve financial support for AI projects, especially in sectors such as oil and gas, where AI has the potential for significant impact, as demonstrated by Sircar et al. (2021).
- **Regulatory Frameworks for AI:** Develop clear and robust regulatory frameworks to guide AI development, ensuring alignment with international standards and addressing ethical concerns highlighted by Zekos (2021).
- **Public Awareness Campaigns:** Implement awareness campaigns to educate the public on AI's benefits and challenges, fostering a broader understanding of AI's potential societal and economic impact.

7.2 Educational and training programs

A strategic focus on education and training is essential for building AI expertise:

- **Integrating AI into Education:** Incorporate AI and data science into university and vocational training curricula. This should be in line with the recommendations of Alzahrani (2022), who highlights the importance of AI education in preparing a skilled workforce.
- **Professional Development and Training:** Develop continuous education and training programs in AI for the existing workforce, tailored to industry-specific needs. This approach can help bridge the current skills gap in AI.
- **Academic Collaborations:** Encourage collaboration between local educational institutions and international universities known for AI excellence. Such partnerships can stimulate AI research and provide practical learning opportunities for students.

7.3 Partnerships with international tech companies or institutions

Forging global partnerships can significantly enhance Libya's AI capabilities:

- **Collaboration with International Tech Firms:** Establish partnerships with global technology companies specializing in AI. This could lead to technology transfer, joint ventures, and direct investment in local AI initiatives, mirroring successful models observed in other developing economies.
- **Active Participation in Global AI Networks:** Engage in international AI networks and forums to stay updated on the latest AI developments and best practices. Participation in these platforms can offer valuable insights and foster international collaborations.
- **Building Academic Alliances:** Develop partnerships with foreign universities and research centers renowned for AI. This could involve student and faculty exchange programs, joint research projects, and shared curriculum development, contributing to a more vibrant AI research ecosystem.

In conclusion, the successful adoption and growth of AI in Libya require a multi-faceted approach encompassing government policy, education, and international collaboration. By establishing a supportive ecosystem through these strategic initiatives, Libya can leverage AI to enhance industrial capability, drive economic growth, and maintain pace with global technological advancements.

8 Conclusion

8.1 Recap of key findings.

This paper has extensively analyzed the role and future of Artificial Intelligence (AI) in Libyan industries:

- **Current State of AI:** AI in Libya is at an early stage, with noticeable progress in the oil and gas sector, as indicated by Sircar et al. (2021). Other sectors, while still in the initial phases of AI adoption, show potential for growth.

- **Impact Analysis:** The integration of AI in Libyan industries is poised to bring economic benefits, enhance job opportunities, and foster skill development, as well as contribute to environmental sustainability, aligning with global trends in AI applications in various sectors (Kakani et al., 2020; Tran et al., 2019).
- **Comparative Analysis:** When compared to similar economies, Libya's AI adoption is relatively nascent. However, there are valuable lessons to be learned from these countries, particularly regarding the development of AI strategies and diversification of applications.
- **Future Prospects and Potential:** The future growth of AI in Libyan industries is promising, especially with the implementation of supportive government policies, educational initiatives, and international partnerships.
- **Policy Recommendations:** Recommendations include the development of a national AI strategy, investments in AI-focused education and training, and the establishment of partnerships with international tech companies and institutions.

8.2 The long-term outlook for AI in Libyan industries

Looking ahead, the long-term outlook for AI in Libyan industries is highly promising. The oil and gas sector are likely to continue as the frontrunner in AI adoption, leveraging technologies for enhanced efficiency and productivity. There is also a significant potential for AI to drive growth in other sectors, fostering economic diversification. The integration of AI aligns with global technological trends and holds the promise of establishing Libya as a competitive player in the increasingly digital global economy.

8.3 Final thoughts on the importance of AI for Libya's economic and technological development

AI is not just a technological tool but a strategic asset for Libya's economic and technological development. Its potential to transform key industries, create new markets, and enhance the quality of life is immense. As suggested by the insights from Ahmed et al. (2023), the integration of AI in sectors like smart cities and infrastructure can significantly contribute to Libya's modernization and development. Furthermore, aligning with the educational strategies highlighted by Alzahrani (2022), Libya can foster a generation of AI-savvy professionals, driving innovation and positioning the country as a knowledge-based economy. The ethical and regulatory considerations, as discussed by Zekos (2021), will also be crucial in ensuring responsible and beneficial AI adoption. In summary, AI offers a pathway for Libya to not only advance technologically but also to achieve sustainable economic growth, diversify its economy, and address various socio-economic challenges. Strategic investments in AI, combined with robust policies and international collaborations, can help Libya leverage AI's transformative power for a prosperous future.

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