International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Investigating Artificial Intelligence Usage in Industries in Ghana: Case Study of Industries in Industrial Area, Accra-Ghana

David Laud Amenyo Fiase[1], Kwadwo Opoku Attah[2], Prince Sackey[3], Freda Ocansey[4], Samuel Lartey[5]

[1,2,3,4,5]Faculty of Engineering Computing and Allied Sciences, Engineering Department, Regent University College of Science and Technology, Accra, Ghana

Abstract:
This research study aims to explore the current state and potential impact of artificial intelligence (AI) implementation in the manufacturing industry of Accra, Ghana, and identify factors contributing to or hindering the successful implementation of AI in Ghanaian industries. The study proposes recommendations for enhancing productivity and competitiveness through AI integration. Focusing on key individuals in the industry, including technical officers, top management, and IT officers, the research gathers valuable insights into the benefits, limitations, and challenges associated with AI adoption. The study employs a mixed-methods approach, combining structured questionnaires and personal interviews to gather data from a representative sample of participants. The questionnaires gather demographic information such as years of experience, company employment duration, type, and size, and the presence of other branches. The results indicate that only a small number of companies in the Industrial Area of Accra, Ghana, have adopted and are using AI for their operations. The findings will shed light on the current utilization of AI in the manufacturing industry of Accra, highlighting its benefits and limitations. The research will also provide insights into the factors influencing successful AI implementation and identify areas and sectors where AI adoption should be prioritized. Additionally, the study will address the potential ethical and social implications of AI implementation, emphasizing the need for equitable and responsible use of the technology.

Keywords: Artificial Intelligence (AI), Industrial Artificial Intelligence (IAI), Data Technology (DT), Analytics Technology (AT), Platform Technology (PT), Operations Technology (OT), Human-Machine Technology (HT)

I. Introduction

1.1 Background Review

According to Kimberly Borden (2022), the term “Artificial Intelligence” (AI) is often overused, obscuring its true definition and purpose. AI is defined as “the ability of a machine to perform cognitive functions typically associated with human minds, such as perceiving, reasoning, learning, interacting with the environment, and problem-solving.” Examples of AI technologies include robotics, autonomous vehicles, computer vision, language processing, virtual agents, and machine learning.

AI involves the development of algorithms and computer programs that can learn from data and make decisions based on that learning. The goal of AI is to create intelligent machines that can reason, understand, and learn like humans. In industrial applications, AI enhances the capabilities of knowledge workers, such as engineers, by harnessing predictive capabilities to make better decisions and provide more accurate conclusions in volatile situations.

Early AI programs focused on tasks such as playing chess and solving mathematical problems. Today, AI is used in various industries, including healthcare, finance, retail, and manufacturing, where it is applied for quality control, predictive maintenance, and supply chain optimization.

Despite the potential benefits of AI, its adoption in Ghanaian industries has been slow due to a lack of awareness, funding, and infrastructure. More investment in research and development of AI technologies and collaboration between academia and industry are needed to develop AI solutions for real-world problems.

Usage of Artificial Intelligence in Industries

The usage of AI has peaked in several sectors globally, including manufacturing, automotive, and finance. This study focuses on manufacturing.

1. Manufacturing

AI in manufacturing improves efficiency, product quality, and employee safety. Applications include:

Predictive Maintenance: AI predicts equipment malfunctions, allowing timely repairs and preventing costly downtime.

Robotics: Collaborative robots, or "cobots," work alongside humans, enhancing productivity.

Quality Control: AI algorithms detect production faults, improving product quality.

2. Automotive

AI applications in the automotive industry include self-driving cars, driver assistance systems, and traffic prediction. AI enhances safety and efficiency in driving and traffic management.

3. Finance

AI in finance includes applications such as loan decision-making, personalized investment portfolios, and fraud detection. AI helps in identifying fraudulent activities early, preventing significant losses.

Industries in the Industrial Area of Accra, Ghana

Post-independence, Ghana's industrial development transitioned from an import substitution industrialization (ISI) strategy to a private sector-led approach. The North Industrial Area of Accra is a hub for manufacturing and commercial activities, and housing companies such as GIHOC Distilleries, Fan Milk Limited, Interplast Ghana Limited, and Kasapreko Company Limited.

1.2 Problem Statement

Despite AI's potential benefits, its usage in Ghanaian industries is relatively unknown. Limited research has been conducted on AI adoption, barriers to AI implementation, and factors influencing successful AI integration in Ghana. This study investigates AI usage in industries in Accra's Industrial Area, identifying challenges and opportunities associated with AI adoption.

1.3 Aim and Objectives

1.3.1 Aim

To investigate the current state and potential of AI usage in industries located in the industrial area of Accra, Ghana.

1.3.2 Objectives:

Conduct a comprehensive review of literature on AI usage in industries, examining benefits and limitations.
Assess the level of awareness and adoption of AI technologies in industries in Accra's industrial area through surveys.
Analyze survey data to identify factors facilitating or impeding AI adoption in industries.
Explore potential AI applications in industries, assessing feasibility and impact on productivity, efficiency, and cost savings.
Recommend strategies for enhancing AI adoption in industries in Accra and suggest areas for future research.

1.4 Research Questions

How is AI currently used in the manufacturing industry in Accra, Ghana, and what benefits and limitations are identified in its implementation?
What factors contribute to or hinder the successful implementation of AI in Ghanaian industries, and how can these be addressed?
How can AI be used to enhance productivity and competitiveness in Ghanaian industries, and what areas should be prioritized for its implementation?
What are the potential ethical and social implications of AI implementation in Ghanaian industries, and how can these be addressed to ensure equitable and responsible use of the technology?

1.5 Significance of Study

The study evaluates the potential and limitations of AI in Ghana's manufacturing industry, identifies factors hindering implementation, and suggests ways to enhance AI adoption. It contributes to the existing literature on AI technology usage in manufacturing, provides insights for policymakers and industry stakeholders, and helps industries maximize AI benefits, and improve productivity, and competitiveness. The findings will be valuable for other developing countries facing similar challenges.

1.6 Scope of Study

The study investigates AI usage in industries located in Accra's industrial area, focusing on AI awareness, adoption, and potential impact. It involves a comprehensive literature review, surveys, and interviews to collect data. The study does not cover all industries in Ghana or technical details of AI implementation but rather focuses on AI's awareness, adoption, and potential impact.

II. Review of Related Literature

This chapter discusses relevant literature, focusing on concepts, theories, approaches, and techniques related to AI in manufacturing. It covers AI advancements, challenges, benefits, limitations, and factors influencing AI implementation in Ghanaian industries, enhancing productivity and competitiveness through AI, and ethical and social implications of AI implementation.

2.1 Industrial Artificial Intelligence (IAI)

Industrial AI focuses on the manufacturing industry's needs, using data analysis, machine learning, and other AI techniques to optimize production processes, reduce waste, and increase efficiency. Key

dimensions include data technology (DT), analytics technology (AT), platform technology (PT), operations technology (OT), and human-machine technology (HT).

2.2 Definitions of Related Concepts

Connected Machines: Machines communicating in real-time through IoT devices.
Smart Industries/Manufacturing: Application of IoT and advanced technologies to optimize manufacturing processes.
Automation Systems: Technology performs tasks automatically to increase productivity.
Internet of Things (IoT): Network connecting various devices for smart recognition and administration.
Industrial Internet of Things (IIoT): Application of IoT in industrial settings.

2.3 AI in Decision-Making

AI analyzes vast amounts of data to provide insights for improved decision-making. Applications include predictive maintenance and quality control, enhancing operational efficiency and productivity.

2.4 Advancements in AI

Advancements in AI, such as machine learning and deep learning, enable more sophisticated AI-based systems, improving accuracy and decision-making capabilities.

2.5 Challenges in AI Usage

Challenges include insufficient data, complexity of technology, bias in AI systems, and the need for specialized knowledge. Mitigating these challenges requires diverse data collection and algorithmic transparency.

2.6 Benefits and Limitations of AI in Ghanaian Industries

AI increases productivity, improves quality control, and facilitates real-time monitoring. Limitations include high costs, need for specialized expertise, and lack of infrastructure and enabling policies.

2.7 Factors Influencing AI Implementation

Factors include organizational culture, leadership, training, communication, collaboration, data availability, and regulatory frameworks.

2.8 Enhancing Productivity through AI

AI enhances productivity by optimizing production processes, reducing downtime, and increasing output. It also fosters innovation and product differentiation.

2.9 Ethical and Social Implications

AI raises concerns about job displacement, algorithmic bias, data privacy, security, and environmental impacts. Addressing these concerns involves ethical AI principles, transparency, data protection measures, and considering environmental implications.

III. Methodology

3.1 Overview

This chapter presents the methodological approach, research design, data collection methods, and data analysis tools employed to achieve the research objectives. It also discusses ethical concerns, validity, reliability, and research limitations.

3.2 Research Design

The research design is descriptive and exploratory, aiming to provide a detailed understanding of AI usage in Accra's industries. It combines quantitative and qualitative methods, including surveys and semi-structured interviews.

3.3 Data Collection Method

Data was collected using interviews and well-structured questionnaires to ensure consistency among respondents. This qualitative approach allows for a comprehensive exploration of AI usage in industrial environments.

3.4 Data Analysis

Collected data was meticulously analyzed to ensure a comprehensive examination of respondents' insights. The findings were scrutinized in relation to existing theories and prior research.

3.5 Structure and Execution of the Research

The research followed a structured approach, using interviews and questionnaires to collect data. Key considerations included ethical concerns, research validity, reliability, and addressing research limitations.

3.6 Ethical Concerns

Ethical considerations involved protecting participant privacy and confidentiality, obtaining informed consent, and maintaining objectivity and transparency in data collection and analysis.

3.7 Research Validity, Reliability, and Credibility

A comprehensive approach ensured the validity and reliability of the research findings. Triangulation was used to validate data from multiple sources and perspectives.

3.8 Research Limitations

Limitations included sampling limitations, data collection constraints, time constraints, and generalizability issues.

IV. Results and Discussion

4.1 Overview

This chapter presents the research results and discusses the findings, including demographic characteristics of respondents, AI awareness and adoption, and the impact of AI on productivity and competitiveness.

4.2 Demographic Characteristics of Respondents

Demographic data, such as company type, size, and duration of existence, provided insights into the

composition of the study population and influenced the analysis of AI adoption and impact.

4.3 Analysis of Personal Observations

Personal observations during the research process provided supplementary insights into AI implementation and its impact on various industrial processes.

4.4 Key Findings

AI Usage: AI is currently used in various areas of the manufacturing industry in Accra, primarily in supply chain management, production optimization, quality control, and predictive maintenance.
Benefits: Improved operational efficiency, enhanced decision-making, cost reduction, and increased product quality.
Limitations: High implementation costs, lack of skilled AI professionals, and resistance to change.
Factors Influencing AI Implementation: Strong leadership support, investment in AI infrastructure, collaboration between industry and academia, and proactive adoption of AI technologies.

V. Conclusion and Recommendation

5.1 Overview

The objective was to investigate AI usage in Accra's manufacturing industry, identify benefits and limitations, and propose recommendations for enhancing productivity and competitiveness.

5.2 Summary of Findings

AI is utilized in about 20% of companies, offering benefits such as improved efficiency and decision-making. Challenges include financial constraints and resistance to change. Key findings highlight that AI usage significantly enhances operational efficiency, decision-making, cost reduction, and product quality in the manufacturing sector. However, challenges such as high implementation costs, a shortage of skilled AI professionals, and resistance to change impede broader adoption. Factors like strong leadership support, investment in AI infrastructure, collaboration between industry and academia, and proactive adoption of AI technologies are crucial for successful implementation.

5.3 Conclusion

This study comprehensively explores the current state and potential impact of artificial intelligence (AI) implementation in the manufacturing industry of Accra, Ghana. It identifies the factors that contribute to or hinder the successful adoption of AI in Ghanaian industries and proposes recommendations for enhancing productivity and competitiveness through AI integration. The research, employing a mixed-methods approach of structured questionnaires and personal interviews, reveals that AI adoption is still in its nascent stages, with only a small number of companies in Accra's Industrial Area utilizing AI technologies. In conclusion, while AI has the potential to significantly enhance productivity and competitiveness in Ghanaian industries, its current usage is limited. Overcoming financial, technical, and cultural barriers is essential for maximizing AI's benefits and ensuring its responsible implementation. This research provides valuable insights for policymakers, industry stakeholders, and other developing countries facing similar challenges in AI adoption.

5.4 Recommendations

5.4.1 Promote Awareness and Knowledge Sharing: Organize campaigns, workshops, and conferences on AI.

5.4.2 Foster Partnerships between Industry and Academia: Facilitate research collaborations and joint projects.

5.4.3 Address Access and Availability Issues: Gain access through top-level management and communicate the research benefits.

Acknowledgment

My acknowledgment goes to Morrison Affel and Prince Ammisah for their advice and help in reviewing this article.

References

1. K. Borden, "The future is now: Unlocking the promise of AI in industrials," Dec 2022. [Online]. Available: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-future-is-now-unlocking-the-promise-of-ai-in-industrials. [Accessed June 2023].
2. E. Shah, "Rule basd Systems in AI," June 2023. [Online]. Available: https://www.scaler.com/topics/rule-based-system-in-ai/. [Accessed June 2023].
3. IBM, "What is Machine Learning," IBM, [Online]. Available: https://www.ibm.com/topics/machine-learning. [Accessed June 2023].
4. E. B. & K. Brush, "Deep Learning," Tech Target, 2021. [Online]. Available: https://www.techtarget.com/searchenterpriseai/definition/deep-learning-deep-neural-network. [Accessed June 2023].
5. S. S. R. Singh, "Artificial Intelligence and machine Learning empower advanced biomedical material design to toxical prediction," Wiley Online, vol. II, no. 12, 2020.
6. R. S. Peres, X. Jia, J. Lee, K. Sun, A. W. Colombo and J. Barata, "Industrial Artificial Intelligence in Industry 4.0 - Systematic Review, Challenges and Outlook," IEEE Access, vol. 8, no. 8, pp. 220121-220139, 2020.
7. H. Kagermann, W. Wahlster, and J. Helbig, "Recommendations for implementing the strategic initiative Industrie 4.0," Final Report of the Industrie, vol. 4, p. 82, 2013.
8. T. O. F. J. R. L. R.-S. Celia Garrido-Hidalgo, "An end-to-end Internet of Things solution for Reverse Supply Chain Management in Industry 4.0," Computers In Industry, vol. 112, 2019.
9. J. Lee, et al., "Industrial Artificial Intelligence: A Comprehensive Review," IEEE Transactions on Informatics, vol. 16, no. 1, pp. 582-598, 2020.
10. N. Kumar, "Internet of Things-IoT: Definition, Characteristics, Architecture, Enabling Technologies, Application & Future Challenges," Amazon Digital Services LLC - KDP Print US, 2021.
11. E. M. A. F. A. K. O. Boateng, "A Review of Artificial Intelligence Applications in Manufacturing Decision-Making Processes," Procedia Manufacturing, vol. 35, pp. 1123-1128, 2019.
12. P. M. M. S. S. Jagtap, "Advancement in Artificial Intelligence for Manufacturing Industries," International Journal of Emerging Technology and Advanced Engineering, vol. 7, pp. 117-121, 2017.
13. S. W. L. S. P. S. B. Choi, "Error Prevention Methodology Using AI Based Smart Manufacturing System," Journal of Manufacturing Systems, vol. 56, pp. 114-123, 2020.
14. E. H. Y. W. Y. C. Y. & S. X. Ngai, "The impacts of knowledge," 2018.

15. J. V. G. Harini Suresh, "A Framework for Understanding Sources of Harm throughout the Machine Learning Life Cycle," Cornell University, 28 Jan 2019. [Online]. Available: https://arxiv.org/abs/1901.10002. [Accessed May 2023].
16. S. & S. A. Barocas, "Big data's disparate impact. California Law Review," vol. 104, pp. 671-732, 2016.
17. G. B. N. G. W. S. T. Sanjaya Lall, Background to Technology Development in Ghana, London: Palgrave Macmillan, 1994, pp. 24-45.
18. C. Ackah and C. Adjasi, Manufacturing Transformation: Comparative Studies of Industrial Development in Africa and Emerging Asia, F. Turkson and C. Newman, Eds., Oxford University Press, 2016.
19. GhanaWeb, "AI and Robotics in Manufacturing: Boosting Efficiency and Quality Control," GhanaWeb, Accra, 2021.
20. Ghana News Agency, "The role of Artificial Intelligence in Ghana's Manufacturing Industry," Ghana News Agency, Accra, 2022.
21. Ghana Times, "Artificial Intelligence and Robotics Revolutionising Ghana's Manufacturing Sector," Kumasi, Accra, 2021.
22. Modern Ghana, "How AI is Optimizing Supply Chain Management in Ghana's Manufacturing Sector," Accra, 2022.
23. Business Ghana, "Leveraging AI for Predictive Maintenance in Ghana's Manufacturing," Accra, 2021.
24. World Bank Group, "Artificial Intelligence for Development in Ghana: Opportunities and Challenges," Accra, 2020.
25. R. O.-B. K.-M. & A.-A. E. Boateng, "A systematic review of artificial intelligence-based tools for decision-making in the Ghanaian manufacturing industry," Industrial Management & Data Systems, vol. 118, no. 5, pp. 1055-1071, 2018.
26. Kusiak, "Artificial intelligence in manufacturing," Engineering Applications of Artificial Intelligence, vol. 73, pp. 1-13, 2018.
27. J. M. G. & A. S. Amankwah-Amoah, "Artificial intelligence in Africa: Advancing sustainable manufacturing and digital economy," Journal of Business Research, vol. 113, pp. 225-236, 2020.
28. E. A. R. & T. M. Agyemang, "An investigation into the factors affecting the implementation of Industry 4.0 technologies in the Ghanaian manufacturing industry," Journal of Manufacturing Technology Management, vol. 32, no. 3, pp. 719-742, 2021.
29. J. S. L. Z. D. Y. T. G. Z. Z. Wang H, "A Comprehensive Review of Artificial Intelligence in Prevention and Treatment of COVID-19 Pandemic," Pubmed, April 2022. [Online]. Available: https://pubmed.ncbi.nlm.nih.gov/35559010/. [Accessed June 2023].
30. F. A. B. A. W. & O. N.-B. Isaac Kofi Nti, "Applications of artificial intelligence in engineering and manufacturing: a systematic review," Journal of Intelligent Manufacturing, vol. 33, pp. 1581-1501, 2021.
31. Merriam Webster Dictionary, "Taxonomy," Merriam Webster. [Online]. Available: https://www.merriam-webster.com/dictionary/taxonomy. [Accessed June 2023].