Exploring Prospects and Barriers to AI Adoption in Ethiopian Manufacturing

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Abstract— As the second most populous nation in Africa, Ethiopia is predicted to make use of modern manufacturing strategies in order to promote its economic progression and alleviate its population from poverty. Artificial Intelligence (AI) has already started to play a critical role in our daily activities and has been implemented in the manufacturing, health care, transportation and business sectors. Recently, manufacturing services have been utilizing emerging technologies such as Artificial Intelligence to manage a variety of industrial operations in order to substitute human cognitive functions, due to the emergence of digitization. This technology is anticipated to revolutionize the manufacturing industry. Several AI-enabled domains in the manufacturing sector are focused on employee management, automated manufacturing operation, product tracking and production monitoring services. However, investing in AI also involves risks that can have a long-term impact on both business and society. Consequently, assessing these risks at an early stage is essential. This paper examines the opportunities and challenges posed by Artificial Intelligence in Ethiopia's manufacturing sector. The study was conducted through secondary research based on the themes of previous studies involving Artificial Intelligence in the manufacturing sector and valid documentation from prominent databases, challenges and their analysis, and finally issues related to the study.

Keywords: Artificial Intelligence (AI) ,Machine Learning, ICT , Manufacturing, Industries ,Ethiopia

1   Introduction

AI techniques are now actually usable thanks to recent developments in computer hardware and embedded sensors for the acquisition of crucial process/machine data, igniting a great deal of interest in their potential applications. A examination of current AI applications also aids in the identification of some particular manufacturing problems for which AI approaches may provide answers, resulting in considerable improvements in productivity, quality, flexibility, safety, and cost. This survey paper's main objective is to examine the opportunities and constraints associated with using AI in a fundamentally novel way to the industrial sector. Up until now, the use of AI in contemporary manufacturing has relied on the long-term development of several strategies, including machine learning [1].Early AI adopters will get the biggest benefits , This presumption has been supported by a McKinsey research, which found that businesses will benefit significantly from adopting artificial intelligence within the first five to seven years as opposed to those that lag behind or follow. The study found that "front-runners" in AI adoption should anticipate a resulting cash improvement of 122 percent, whereas "following" can anticipate a far lesser effect of only 10 percent.As a result, the cost of not adopting AI or doing it late is enormous. Considering the possible advantages of AI technologies, there are deployment hurdles. If done without conscious engagement, structural, economic, social, and political imbalances could beÂ imminent, and existing inequities may become even more entrenched. Non - uniform access to technology is an important challenge for regulators and policymakers around the globe along with its potential to exacerbate social and economic inequality. The researcher conducted an empirical study by reviewing relevant articles on AI prospects and challenges by looking atÂ developed-world experiences as well as third world countries in Africa, and then providing a discussion to identify prospective opportunities and anticipated challenges on AI adoption and implementation in Ethiopia.Finally, the writer provides recommendations as to what should be done for proper AI adoption in Ethiopia .

2   LITERATURE REVIEW

Many organizational difficulties can be handled using AI and ML concepts and platforms [2] . Thus, critical concepts of the paper refer to artificial intelligence with regards to the manufacturing industries [3] .The adoption of AI in

manufacturing is shown to be most influenced by organizational characteristics including digital skills, firm size, and RD intensity. [4] Moderating element for AI adoption is leadership support. besides ,all associations on perceived ease of technology use were found to be significant in the context of digital manufacturing and production firms, with the exception of organizational preparedness, organizational compatibility, and partner support.

2.1 Ethiopian Manufacturing Industries

A recent research conducted across manufacturing industries in ethiopia, by [5] highlights that About 45.5 percent of the manufacturing industries under survey responded that their production technology is "not enough" to produce quality product.[5]Pointed out that Technology adoption rate is low as it raises the firms to have adequate and continuous investment not only on technology and related deployment assets, but also on skilled labor to operate it . [6] Meeting productivity, quality, and cost targets while ensuring a safe working environment for all are the key driving factors and requirements throughout most regular manufacturing operations across industries. However, achieving these aims has grown more challenging given the com-plex nature of processes and products, growing consumer demand and preference unpredictabil-ity, and diminished competitive incentives from rival businesses to be successful. In a flattering perspective, the challenging operating environ-ment in which most manufacturers find them-selves presents an opportunity for AI's unique capabilities to outperform traditional tools and approaches.

Figure 1: Source: https://africanmake.com/ .

2.2 AI Adoption in Ethiopia

Ethiopia would be prone to be affected by the high disruption of artificial intelligence because of its socio - economic and political interconnections with several other countries that are embracing and implementing artificial intelligence, according to [1].African countries spanning Kenya , Ghana , Nigeria to Egypt, as well as other African nations, are bracing for the

new wave of artificial intelligence since AI might contribute up to 15.7 trillion dollar to the world economy in 2030, more than the current out-put of China and India combined [7]. ChowNet, Africa's ImageNet for food photos, was developed by the team at AI Saturdays Lagos in attempt to address challenges relatedÂ to AI adoption in Africa.Nevertheless, [8] argues that AI deployment is a mirage in Africa, not a reality, save in a few countries: Kenya, South Africa, Nigeria, Ghana, and Ethiopia.

Because of the continent's peculiar geographical, cultural, and political characteristics, the continent's 4th industrial revolution is unfolding differently than its global counterparts [9]Artificial intelligence (AI) advancement and incorpora-tion in Africa has been slower than in advanced economies.[10] highlights ,South African star-tups that have created cutting-edge AI solu-tions or have come up with potentially disrup-tive AI technologies. West African countries like Ghana, are developing AI-enabled products that could be used in a variety of situations which are mainly focused into three main sectors :ma-chine learning for analytics, software develop-ment for platforms, and value added services such as payment and SMS that provide value to the consumer.[11] In a recent study conducted by O'Reilly, it was revealed that far more than half of the difficulties encountered while deploy-ing computer vision and artificial intelligence services were due to a lack of knowledge, data, or relevant use cases.The research of O'Reilly would be illustrated in the following.
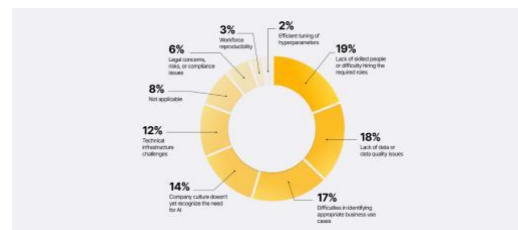

Figure 2: Source: https://www.exposit.com/

3 Materials and Methods

The method used in this work was exploratory research.Secondary research method is used to harness existing resources on the subject under study. For this exploratory research, researchers investigate already-existing online sources including journals, newspapers, magazines, papers, etc. Exploratory research design does not attempt to provide definitive answers to research questions, but rather to investigate the study issue in various levels of detail (John Dudovskiy 2016) and to handle novel challenges on which

little or no previous research has been conducted (Brown, R.B., 2006). There have been no published studies on artificial intelligence with re-gard to manufacturing sector in Ethiopia, thus this study attempts to contribute some knowl-edge as a foundation for exploring the prospects and problems of AI in Ethiopia. The author expanded on the ideas presented in the study by citing related literature from other nations that have adopted and implemented AI, including some initiatives that originated in Ethiopia.

4   Discussion

4.1   Challenges of adopting AI

In comparison, Ethiopian manufacturing firms adopt soft technologies more readily than hard ones. According to the findings[12], good orga-nizational and environmental factors ,with the exception of firm age, has a positive impact on a firm's level of technology adoption. There was a significant relationship between firm size, certification, competition, employee technical skill, financial resources, and government sup-port. The results, on the other hand, showed that the level of technology adoption was not significantly impacted by the top management's commitment or the firm's age.There is a dearth of information on the levels of ICT proficiency attained in the Africa region at the basic, stan-dard, and advanced levels. However, it is evident that there is a large skills gap (Figure 4).More data must be gathered in order to improve un-derstanding and target future attempts to close the skills gap.

- Awareness of Industries

As Ms. May yap (2021) ,highlighted in her paper titled âThe Impact of AI in Manufacturing: Un-leashing Productivityâ . Todayâs manufacturing business is equally as reliant on automation as it is on humans. However, the factory of the future, which is a hybrid of physical and digi-tal capabilities, will need more: real- time data, connection, and artificial intelligence (AI) at its core .Though, some manufacturing industries have heard about AI ,the Manufacturing indus-tries especially local ones do not know what and where to apply Artificial intelligence. An AI strategy needs to start with business applica-tions. In order to prior- itize projects based on expected business outcomes and implementation effort, manufacturers should have a clear picture where they want to employ AI in their short and long term strategy. They should also collect all of the use cases throughout their operational processes in an organized format, melding them

by purpose. This assists in locating possible âlighthouseâ and âpilotâ use cases that could pave the way for the companyâs AI aspirations. Such prominent and early use cases are crucial to success because they encourage the adoption of AI throughout the firm. The technologies and organizational requirements will be determined after the broad vision and specific use cases have been established

Figure 3: Source: Digital trends in Africa 2021

- Availability of Data

The World Bank (2017) noted in its report on Ethiopia that Ethiopia has one of Africa's most famous statistics collecting agencies, mainly for agricultural data. Nevertheless, [13] has identi-fied that several researchers and data collection teams in the Sub-Saharan Africa (particularly Ethiopia) are not classically trained in data gathering and that, as a result, quality of the data and reliability usually not satisfactory. Every AI project must start with quality data. In order to successfully integrate AI algorithms to the company's processes, dependable and accurate data collecting, administration, and governance are essential. In the manufacturing industry, sensor data from linked industrial equipment could be vital data source, therefore the production line and factories are crucial to the data-acquisition process.To gather un-processed data from sensors, Manufacturing Execution Systems (MES), maintenance pro-cedures, and quality checks in one location, several businesses are using "data lakes." In order to obtain a 360-degree picture of both their production process and the product, they are also enhancing it with outside data.

To keep track of all information and data flows available , to make the data easily accessible to a huge number of participants, and to main-tain correct data cataloging and data lineage are all requirements for theÂ massive data-management systems in manufacturing indus-tries .To comprehend the data volumes, veloci-ties, and variety manufacturers should begin by visualizing their primary data objects, such as manufacturing facilities, machinery, and prod-ucts, and the related data sources. A key obsta-cle to integrating AI is often defining data qual-

ity indicators and routinely monitoring them to raise awareness of their significance.[11] Due to data privacy concerns or data inaccessibility, various firms may struggle to acquire the appropriate data for model training.

• Technology

Big Data, analytical, and AI technology are all still developing quickly, which frequently leaves businesses unsure of their future IT architecture and the best vendors and tools to use. Manufacturers ought to begin utilizing a "functional reference architecture," which identi-fies the tools required by the business to collect, handle, store, and process data as well as the essential analytic and visualization tools. Indus-tries can outline their criteria for an evaluation of the best technologies on the market using this functional architecture, and they can also specify the technical and infrastructural setup they want to use.[14]In Africa Infrastructure for ICT has been relatively developed well by the private sector. Although their contributions are constrained, they ought to be supported and rewarded. When it comes to policy (like taxation), better approach should be considered to enhance ICT deployment .

Some open-source technologies have supplanted commercial Big Data and AI platform offer-ings as the de-facto norms for Big Data man-agement and AI. The development of complex machine-learning models is made possible by these technologies, which also enable scalable distributed data processing. Machines can al-ready recognize complicated patterns and ab-normalities thanks to these machine-learning models.To handle data streams from sensors in a production environment, manufacturers need pay close attention to "time series" data process-ing and analytic capabilities.

• Skilled Labor and Organisation

More data and new technology necessitate the recruiting of manufacturing specialized.analysts with specific analytical skills. Companies have begun to hire data scientists in recent years, but they have yet to discover the ideal organi-zational structure to make efficient use of these new abilities alongside traditional engineering skills.

Manufacturers who are embarking on a transfor-mation journey frequently find that they must

begin with a dispersed and uncoordinated use of data and AI experts before moving on to a more centralised organizational model, which determines the organization's AI maturity level. AI capabilities might revert to being decentral-ized in the final stage once they have been fully integrated into the organization.AI team should include data engineers, data stewards, solution architects, and analytic interpreters in addition to data scientists. The teams from the differ-ent industrial operations then collaborate with all these central resources to cooperatively de-vise and execute AI applications for distinctive use cases. The support team regularly monitors the formation of a central AI platform on the technologies mentioned above, which usually entails the employment of platform architects and DevOps personnel. [15]Explained the fact that, although some advocate possible negative effects of AI , there isn't much data to back this assertion, making this a significant topic for further study.

• Culture

Ethiopian industries have to establish an infor-mation and AI-driven decision making culture. By trying to educate the workforce concerning AI, its capabilities, and value, including its risks and limitations, they can meet the AI deploy-ment objective by encouraging utilization of data and algorithms. In order to sooth worries that AI will eliminate thousands of manufactur-ing jobs, they must simultaneously manage the fears of their workforce and present a convincing vision of successful human-machine collabora-tion.Any organization's culture is determined by its leaders. Executives must take the initiative and set an example in order to create a data driven decision making culture.[16]A decision-process that prioritizes testing and experimen-tation, in which data prevails over views, and in which failure is accepted as long as something is learned as a result of it are characteristics of a data-driven culture.

• Process

The Ethiopian MFG must set a minimal degree of AI governance and processes in order to operate efficiently.An illustration of such a pro-cess is AI use-case pipeline management, which regularly detects and assesses new use cases in the organization, schedules their adaptive approach, and provides a seamless entry into operations. Another illustration is a clearly de-fined method to developing AI solutions. These

typically outline the stages of data analysis and the development of AI technologies and are based on the CRISP-DM cross-industry known data mining approach.

4.2   Opportunities of Adopting AI

Three technology mega trends, including connectivity, intelligence, and flexible automation, are the primary forces behind a manufactur-ing paradigm shift associated with the Fourth Industrial Revolution [17].Company executives who move on with implementation as soon as possible rather than waiting for cheaper technology and deployment-related costs will see the highest value. The competitive advantage of front-runners, which significantly outweighs the higher transition costs and capital expenditure connected with early adoption, is therefore the most crucial factor.[18]Three factors, including application technology, industry, and applica-tion effect, may be taken into account when evaluating the integrated application of AI in the field of intelligent manufacturing.[19] put forth a number of ideas to facilitate technology transfer to Ethiopian Industries. The solutions that are being suggested primarily center on technology policy, technical advancement of higher education institutions, application-focused science and technology education, coordinated stakeholder participation, applied RD, university-industry links, and the creation of the Â Innovation Centre and Technology Incubation Center.

•   Early Adopters Benefit

According to [20] significant technological factors have had a variety of visible effects on the competitiveness of the Ethiopian manufactur-ing firms. The outcome of [20] demonstrates that nine technological factors are important and highly influencing industries' competitive-ness.Customers that accept products before the majority of other customers are known as early adopters. Based on the diffusion of innovation theory, these adopter categories are classified according to the customer journey. According to the diffusion or product adoption curve, the inventors are the first to acquire the product as soon as it is released. when a customer uses a product or service early on, it shows that the product or service is well-liked at the time.

According to a McKinsey report from 2021, corporate executives that act quickly rather than waiting for less expensive technologies and transition costs will reap the greatest rewards. Therefore, the competitive advantage of front-

runners typically outweighs the greater transition costs and possible penalties associated with early adoption in this scenario.
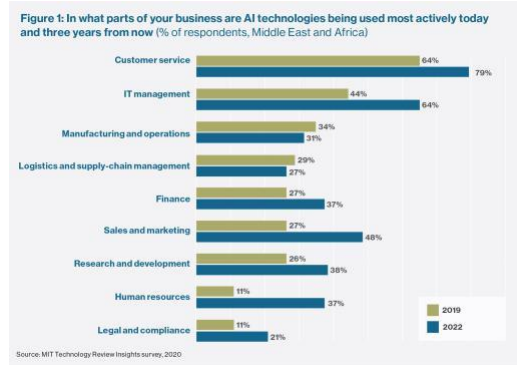

Figure 4: Source:MIT Technology Review,2020 on AI adoption areas in Middle east and Africa

•   Refine Product Inspection and Quality

In a typical production environment, automated optical inspection (AOI) machines are used to determine which goods satisfy standards and which are defective; however, these machines have an accuracy rate of about 60-70 percent, which is acceptable in a classroom setting but not exceptional. And, as I previously stated, one of the most important aims in the manufactur-ing industry is to achieve good quality.When we use AI to complement manufacturing processes like AOIs and educate it to spot patterns, we can improve process optimization significantly. As a result, accuracy rates will increase .

•   Augment Human Capabilities

Artificial intelligence's ultimate goal is to make processes more efficient with minimal human involvement. People and industrial robots can work together to make work less manual, tedious, and repetitive while also improving accuracy and efficiency.

•   Enable Preventative Maintenance

Extensive breakdowns of a set of utility machines cause significant delays to the primary production lines[21]. The down-times had an impact on the departments' KPIs and the company's profitability, forcing the management to concentrate on firefighting style of opera-tion.With machine learning ,Predictive main-tenance could be done examining machine performance data in the past to predict when they are likely to break, reduce the amount of time they are out of service, and pinpoint the core cause of the problem. Yield-energy-throughput (YET) analytic can be utilized to ensure that

those specific machines are as efficient as possi-ble while in operation, allowing them to increase yields and throughput while consuming less en-ergy.A recent research by [22] shows the viability of using artificial intelligence (AI) to diagnose the state of a railcar wheel bearing, predict its remaining useful life (RUL), and choose the best time for maintenance.

5 Conclusion

The Ethiopian government has the ability to make AI's potential a reality for its population. While there are many challenges to be addressed, there is also a prospect to gain the competitive edge by capitalizing on the wisdom of nations which have become leaders in AI.[23]Economic factors are primarily behind the adoption of AI in various sectors, there are also technical and societal hurdles to overcome, including greater dependency on non-humans, job stability, a lack of expertise, safety concerns, and a lack of view-points from diverse stakeholders.Though,some of the issues needs to be tackled by private man-ufacturing sectors the government and higher learning institutions in Ethiopia should take a lead by creating conducive environment.

- Benchmark other countries

Artificial intelligence technology development is a global race, and several countries are compet-ing for first place. Both the public and private sectors are actively deploying AI applications, and numerous countries are well on their way to overcoming challenges and gaining significant benefits from this emerging technology.Thus, Ethiopia could follow the footsteps of counties who succeeded in deploying this technology and adopt it in localized context.

6 Recommendations

Before trying to consider AI adoption compa-nies need to Investigate and Identify Potential AI Implementation Opportunities. Prior to in-vesting resources, firms should understand AI technologies and where to apply it ,Recognize the risks and return on investment (ROI) of integrating artificial intelligence into their pro-duction system ,should Establish Connections With Subject Matter Experts Who Focus on AI Adoption and Implementation and Utilize in an agile methodology and a people-focused approach .Besides ,the following points should be taken into account by respective stakeholders :-

- Ethiopian Government Research institu-

tions should bench-mark other countries and Develop AI Strategy that Works for Ethiopia.

- Government should create strategies and policies that encourage the use of AI in manufacturing.

- Ethiopia must strengthen its ability for ICT policy in order to respond to shifts in the Information technology environ-ment, build strong cybersecurity frame-works suitable to handle big data and adopt AI, and ensure stable business con-ditions for private sector involvement .

- Access for a reliable and supportive IT infrastructure.

- A strong regulatory and policy frame-work; a collaborative environment where all stakeholders can learn from one an-other.

- Future research on AI adoption in other sectors such as Ethiopian farming industry

- Develop AI Strategy that Works for Ethiopia

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