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Impact Of Artificial Intelligence And Big Data On The Oil And Gas Industry In Nigeria

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***Abstract*— This paper examines the concept of Artificial intelligence and Big Data as a field of study and its Impact on the oil and gas industry. Artificial Intelligence refers to the concept having of Computer systems that can perform tasks that would typically require human intelligence. Some such tasks are visual perception, speech recognition, decision-making and translation between languages, amongst others. "Big data" or Big Data analytics is a term often used to describe a huge or somewhat overwhelming data size that exceeds the capacity of both humans and the traditional software to process within an acceptable time and value. There is a big interface between the two concepts. AI does not stand alone; it requires big data for efficiency. AI and Big Data have brought about great impact across different industries and organizations. In the oil and gas industry, there have been an increasing installation of data recording sensors, hence data acquisition in exploration, drilling and production aspects of the industry. The industry is gradually making use of this huge data set by processing them using AI enabled tools and software to arrive at smart decisions that bring efficiency to operations in the industry. Some of such areas are analysis of seismic and micro-seismic data, improvement in reservoir characterization and simulation, reduction in drilling time and increasing drilling safety, optimization of pump performance, amongst others. Some of the solutions listed above have been successfully implemented in Nigeria, mostly by the international oil companies and some additional areas have also been impacted: managing asset integrity, tubular tally for drilling operations using RFID and the licensing and permit system by DPR. The industry has fully embraced the AI and Big Data concept, the future is very bright for more innovative solutions. However, there are still a few challenges especially in Nigeria. Some of these challenges include lack of local skilled manpower, poor data culture, security challenges in the industry's operating areas, limited availability of good quality data, and understanding the complexity of the concept.**

Keywords— ***Artificial Intelligence, Big Data, Nigeria, Oil & Gas.***

I. INTRODUCTION

Mobile devices, aerial (remote sensing), software logs, cameras, microphones, RFID readers, and other wireless sensor networks, all of which are part of the Internet of Things (IoT), generate enormous amounts of data every day. This data can be used for a variety of purposes, including research and analysis. Seismic surveys, drilling, production, refineries, and retail operations all create massive volumes of data in the oil and gas industry (Shi, et al; 2020). Oil and gas companies regard managing large

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datasets as both a chance and a serious risk. Many organizations, including the oil and gas industry, are utilizing artificial intelligence (AI) to analyze and interpret this vast dataset. For example, drone-based aerial intelligence, predictive maintenance for equipment, or the use of robots to address industrial safety issues in locations that are too dangerous for humans to access are all examples of how AI and Big Data have come together to give significant value. This combination has made some positive impact on activities in the industry, with a potential to bring more transformations. Smaller, more focused and elite teams are forming in the industry because of this belief. Because they are able to provide more value in an efficient manner, this sets them up for long-term success.

As a result of so much investment, a number of significant advancements have been made. According to research, the artificial intelligence (AI) market in 2019 was worth $2 billion, and it is expected to reach $3.81 billion by 2025. For more information on this topic see (Bharadwaj, 2019). BP, a major oil company, invested in the startup technology firm Belmont Technology in January 2019. With the help of this cloud-based geoscience platform, the company hopes to improve artificial intelligence in the oil and gas industry by utilizing cognitive computing and machine learning. Belmont Technology made its debut in 2018. According to Microsoft's announcement in October of this year, the energy sector will benefit from the company's collaboration with Baker Hughes and C3.AI, an AI developer. Microsoft's Azure cloud computing platform is compatible with these technologies. Inventory management, energy management, predictive maintenance, and equipment reliability may be made easier for customers by AI. As part of an effort to minimize costs, enhance business processes, and generate revenue, Shell stated in February 2020 that it will develop an online programme to teach its staff artificial intelligence skills. It will also allow the corporation to analyze a massive amount of data across all of its operations to develop fresh insights and stay ahead of the competition. An increasing number of foreign oil corporations are working to bring their AI advancements to the Nigerian market, as well as adopting new AI-based solutions for some of the country's unique asset integrity and drilling difficulties, among other things.

This paper presents an extensive overview of the impact that AI and Big Data have had in the industry, both globally and within Nigeria. It starts with the history of AI and Big Data and goes further to examine what has been achieved so far in the areas of exploration, drilling, reservoir engineering, production and the downstream sector. It also presents the outlook and the future potential of AI and Big Data for the industry and concludes with the challenges mitigating against harnessing the full potential of the concept within the Nigerian industry (Damilare, 2019).

II. Literature Review

History of the Oil and Gas Industry

The oil and gas industry have gone through major transformations spanning several centuries. These transformations were driven partly by advancements in technology, resulting in significant milestones recorded in the industry and as a result of an increasing relevance of oil, and later gas, as an energy resource. Although often overlooked in modern historical accounts, the Chinese are known to be the first civilization to have carried out drilling operations howbeit for salt. According to Kuhn (2004), about 2,250 years ago, the Chinese started drilling wells to penetrate brine aquifers to harvest salt, essentially ground water with salinity of over 50g/l, by allowing the water to flow to the surface and get evaporated with a heat source, leaving the salt behind. A few decades later, the transition had taken place from hand dug wells to percussively drilled wells using iron drill bits, bamboo drill pipes, a rig and pipelines all made up of bamboo trees. Despite the fact that the Chinese pioneered the drilling industry centuries ago, Colonel Drake's oil discovery in Pennsylvania in 1859 and the Spindle top finding in Texas in 1901 are frequently cited in most records as the moment the oil industry began (Gerali, 2016, Gerali, and Gregory, 2017). Before this period, very little was known of oil as an energy source. In terms of relevance and value, wood, and later coal, had long held positions of significance in the 18th century and provided the energy needs that helped fuel the global economy. According to Yergin (2020), during the industrial age, coal gained relevance as the preferred fuel and contributed to the massive growth in the scale of industrialization recorded during that period. Coal was used to drive locomotives for land transportation and to fire steamships for the intercontinental maritime trades. However, with the dawn of the 20th century, there were environmental concerns regarding the use of coal and together with advancement in new technologies necessary for exploration and production of oil, there began a gradual shift in the energy mix from coal to oil. Although oil was considered a "greener" energy source than coal, its byproducts such as kerosene provided a reliable and relatively inexpensive alternative to "coal-oils" and whale oil for lamp fuel. This transformation was facilitated significantly by rising automobile ownership and need for power, which resulted in an enormous increase in oil demand. By 1919, gasoline had outsold kerosene in terms of sales. Military aircraft and ships that ran on oil

demonstrated that oil was not only an important source of energy, but also a valuable military asset during World War I. Previously, natural gas that was produced at the same time as oil was simply burned off as waste (also known as "flaring"). As a result, gas became a common source of energy for both commercial and residential heating and electricity. Natural gas became a desirable commodity as its value was realized (Yergin, 2020). As stated earlier, several technological innovations, arising from research and development initiatives, have led to significant transformations in the oil and gas industry. A few of such innovations that have made huge impacts in the industry include: directional drilling technology which came with the invention of mud motors and rotary steerable tools, deep water drilling and subsea control modules, hydraulic fracturing, enhanced oil recovery, SAGD (steam assisted gravity drainage), CSS (cyclic steam stimulation), including various suites of software used for seismic data processing, static and dynamic reservoir modeling, well designs, amongst others. These innovations have introduced efficiencies and resulted in improvements on how the industry conducts its various range of activities; from upstream operations (seismic survey, drilling operations, reservoir engineering, production optimization) to downstream (refining, petrochemicals, trading, product marketing and retail). In recent times, some innovative ideas have emerged at the global stage that the industry has taken advantage of to drive efficiency and productivity. One of such innovations is the application of Artificial Intelligence and Big Data to activities in the industry Adekoya, (2019).

The Concept of Artificial Intelligence

The idea and practice of creating computers capable of performing tasks that normally require human intelligence is known as artificial intelligence (also known as AI for short). Being able to see, recognizing spoken words, making decisions, and translating languages are all examples of these kinds of tasks. Applied artificial intelligence (AI) research is not a new field of study. Although artificial intelligence has been studied for decades, it has only recently received more attention. Alan Turing, a British mathematician, began working on the "Enigma" code used by German soldiers during World War II in the 1940s. The "Enigma" code was one of the primary means by which German soldiers communicated during this period (Ray, 2018). Enigma messages were deciphered using the Bombe machine during World War II. Alan Turing and his colleagues created it (Turing, 1950). It was thanks to the Enigma and Bombe machines that computers will one day be able to learn on their own. Invention of the "Imitation Game" is widely credited to Alan Turing (Turing, 1950). Alan Turing believed that a machine was intelligent if it was able to communicate with a human without the human being being aware that they were communicating with a machine (Turing, 1950). The phrase "Artificial Intelligence" was coined in 1956 by John McCarthy (McCarthy, 1959, Woo, 2011 and Roberts, 2016), an American computer scientist who hosted a meeting on the Dartmouth College campus. One of the conference's key highlights was the forecast that a machine as intelligent as a human would exist within a generation. The majority of those who attended the conference went on to become pioneers and leaders in AI research for an extended period of time. Following that conference, the field of AI gained significant research funding in the millions of dollars to realize this objective. Over many decades following the conference, advancements in AI went through several booms and bursts (the so called “AI Winters”), representing periods of high interest (and robust funding) and apathy (and limited funding) for AI research respectively (Cockburn 2018).

Artificial Intelligence in the 21st century

At the turn of the new century, there was a resurgence of interest in artificial intelligence, particularly in the United States and Japan. For example, the Japanese government has stated that it wants to build a fifth-generation computer to advance machine learning, and a number of American businesses have expressed an interest in AI. In the past, many people believed that computers would one day be able to speak, translate languages, understand images, and think for themselves, as Ray (2018) points out in his book. Deep Blue was the first computer to defeat Garry Kasparov, the reigning world chess champion since 1985. Deep Blue was created by IBM. In the early 2000s, when the dot-com bubble burst, some of the AI funding dried up. Even so, the field of machine learning has continued to advance, which can be partially attributed to advancements in computer technology. In a small number of fields, businesses and government agencies have successfully implemented machine learning techniques. Computers now have a lot more processing and storage space than they did in the past thanks to advancements in microprocessors. For the first time, businesses have been able to store and analyze large amounts of data. Machine learning has helped companies like Amazon, Google, and Baidu make billions of dollars over the past 15 years. Additionally, these companies have developed a wide range of AI applications to learn more about how their customers behave. Computer vision, natural language processing, and other applications are among them. Many web services we currently use incorporate machine learning into their operations. As a

result, Artificial Intelligence technology is now employed to power operations in a wide variety of businesses and sectors, including the oil and gas industry (Liu et al, 2018).

The Concept of Big Data

Massive amounts of information can no longer be handled by humans or older software in a reasonable amount of time or money without resorting to "big data," also known as "data analytics." This term is frequently used to describe the collection and analysis of "big data." The term "big data" refers to the collection and analysis of large amounts of data. "Big Data" can also be viewed as an academic field that studies various methods for analyzing, obtaining information from, and dealing with large amounts of data that are either too large or complex to be processed by the typical software used for data processing (DeMauro et al; 2016). The process of gathering, storing, analyzing, searching, transferring, sharing, visualizing, querying, and updating data is known as Big Data. Keeping information private and determining where it came from are also part of the process. "Big Data's five V's of Big Data," as they're now known, were the initial focus of the term "Big Data." Data quantity, variety, speed, accuracy, and monetary value are all considered here. The importance of the five V attributes of Big Data are as follows: volume (the large size of the data), variety (different types and sources of data), velocity (ability to have data in real time or fast enough), veracity (data quality, completeness and accuracy) and value (making commercial sense from data and harnessing business opportunity from it).

If you want to get value from any size dataset, you need predictive analytics, user-behavior analytics or other advanced data-analytics techniques like these. "Big Data" is a term that is frequently uttered today. Big Data focusses on how to carry out analyses of certain data sets to make inferences, generate solutions, take business decisions, spot trends, and prevent diseases, combat crime, amongst others. Many IoT devices and methods generate enormous amounts of data on a daily basis. every day. In addition to mobile devices, aerial (remote) sensing (also known as remote sensing), software logs, camera/microphones, RFID readers, and wireless sensor networks, other methods and devices include: Remote sensing can also be performed with mobile devices. The amount of data that can be stored globally has nearly doubled every 40 months since the 1980s. Exabytes (2,526,096 bytes) of data were generated daily in 2012, and this number is only going up from here on out (Jain, A 2016). The oil and gas sector is increasingly relying on sensors to monitor and create massive amounts of data across all segments, both upstream and downstream. In the oil and gas industry, big data has numerous applications, including seismic and microseismic data analysis; reservoir characterization and simulation; drilling time and safety; pump performance optimization; petrochemical asset management; shipping and transportation; and workplace safety. These are just some of the many uses for big data (Mohammadpoor & Torabi, 2020).

The marriage between AI and Big Data

AI has already brought in major transformations in our everyday life; from using our phones to complete banking transactions, receiving targeted or customized ads while browsing internet, to having internet-of-things (IoT) smart devices at home. More transformations are still ahead of us, including in the oil and gas industry. There is an ongoing explosion of data globally, leading to a radical transformation in information technology. Over 90% of the ecosphere's data were created in the last 2 years and it is expected that data will increase by more than 5 folds in the next 5 years and this vast volume of data is transforming our lives in ways unimaginable even a decade ago Dan Jerkens, Shell Energy Podcast (2020). This data volume makes information accessible, but most importantly makes algorithms much smarter and it is this that has been powering the AI revolution. In many ways AI is transforming our lives for the better, having a wide-ranging impact on the society and most importantly on the oil and gas industry. AI can deal with large and complex data sets in ways that both the traditional data processing tools and humans cannot handle (Bernardone, 2018). This is what drives the marriage between AI and Big Data. A good example to illustrate this connection is to examine the Banking industry. Most banks have apps that stream millions of very critical data every second and they send alerts whenever anomalies occur, like fraud or theft. This cannot easily be done by humans. Humans would require an enormous amount of time and effort to process or analyze even a small fraction of this volume of data on a second-by-second basis in order to prevent or halt a crime.

Even with a large number of employees participating in data processing to detect fraud, the sheer volume of data overwhelms human decision-making capabilities. The primary issue for traditional data processing technologies is that they are algorithmic, which means they must repeat the same logic again and over. When there are anomalies, flexibility is frequently necessary, and typical tools are frequently insufficient. However, the application of AI and machine learning frequently results in the capacity to

forecast an outcome based on patterns generated through Big Data research. With AI, the system may consider one option initially then abandon it if additional data refutes a line of reasoning, at which point it will consider a new direction. Machine learning systems are well-suited for finding abnormalities over time because they become wiser as more data is fed into them. According to Nordlinger, (2019), the connection between AI and Big Data works through six principles: Extrapolation, Anomaly Detection, Bayes Theorem, Graph Theory, Pattern Recognition and Automating Computationally Intensive Human Behavior.

Extrapolation: Extrapolation is the process of guessing the value of a variable beyond the range of the original observation based on the relationship between that variable and other variables. For example, if a data set shows a trend, the organization's decision makers want to know where the business will be in three months if the trend keeps going as it has. Artificial intelligence can process huge amounts of data and come to these kinds of conclusions. On the other hand, trends may or may not follow a straight line. Linear trends are easy to spot; all you need is a simple line chart. Extrapolation functions are helpful because it is harder to understand nonlinear trends than linear ones. These procedures are based on equations that are polynomial, conic, or curve-like (Bernardone, 2018).

Anomaly Detection: Anomalies or outliers in data can be found with the help of AI and Big Data. These are events, situations, or observations that don't fit into a pattern or don't make sense with the rest of the data. Anomaly detection is used for a number of things, like finding faults, keeping an eye on the health of a system, using sensor networks, and finding disturbances in eco-systems (Bernardone, 2018).

Bayes Theorem: The Bayes theorem talks about how likely an event is based on what you already know about possible confounding variables. The Bayes theorem is named for Baye, who came up with it. It's helpful to use similar past experiences to predict the future. For example, if a company wants to know which of its customers are most likely to leave in the future, it can use Bayes theory to look at historical data about unhappy customers and then use this data to make predictions about which customers are most likely to leave in the future. This is a great use of big data because the more historical data that is put into a Bayes algorithm, the more accurate its predictions become (Bernardone, 2018).

Graph Theory: Graph theory is the study of mathematical structures and how those structures can be used to show how two different kinds of things are related to each other. In this conversation, a network is a group of vertices, nodes, or points that are connected by edges, arcs, or lines. It is possible for it to be very complicated and cover a lot of ground. Graph theory makes it easy to understand how the data points relate to each other. Think about a complex computer network as an example (Bernardone, 2018).. The study of graph theory can show not only how a bottleneck in a network can cause more problems, but also what caused the bottleneck in the first place. Kannaiyan et al; 2021.

Pattern Recognition: Pattern learning is a machine learning approach that is used to data in order to find patterns and abnormalities. Unlike anomaly detection, which looks for abnormalities in a single type of data, pattern recognition can uncover previously unknown patterns in many types of data while also taking into account the patterns (or links) between the data (Bernardone, 2018). For instance, a business may be interested in determining when something unusual begins to occur, such as when consumers begin purchasing one item in conjunction with another.

Automating Computationally Intensive Human Behavior: Humans have constraints in terms of the amount of data they can analyze, whereas AI allows for almost endless data processing. Human knowledge can be extracted, stored, and manipulated using rule-based systems for the aim of understanding data in usable ways. In reality, rules are made up of a series of "if-then" clauses that are based on what people have done in the past. The rules for how to respond to these claims come from the claims used in them (Bernardone, 2018). Rule-based systems can be used to make software that can solve problems even when no human expert is available. "Expert systems" is a term often used to describe these kinds of systems. Consider a company that has spent money on a person who can analyze data for a specific purpose (Bernardone, 2018). On the other hand, the work is boring and done over and over again. This expertise can be captured and automated using a rule-based framework.

Oil Industry, AI and Big Data

The oil and gas industry is composed of three primary divisions: the upstream, midstream, and downstream divisions. Upstream activities include the discovery of new oil and gas reserves and their subsequent production. "Midstream" is commonly referred to as "transportation and storage," whereas "Downstream" refers to the entirety of oil refining and marketing processes (Bharadwaj, 2019). Every year the oil and gas industry spend an increasingly significant amount of money in exploration and production

activities in order to optimize production of oil and gas resources to help meet the global energy demand. However, at the same time, there are increasing concerns and pressures from some stakeholders regarding the environmental impacts arising from the activities of the oil and gas industry. As a result, oil companies have adopted some innovative options to achieve their business goals while reducing the environmental impact of their activities. One of such innovations is the use of Artificial Intelligence and Big Data (Wu, et al 2014).

The industry is increasingly relying on AI to process Big Data to enable it bring efficiencies and improvements to how it conducts its activities. According to Wood, (2020), the oil and gas industry spent about USD2 billion in 2019 and the spend is expected to reach USD3.81 billion by 2025.The AI spend in the industry is largely driven by the major industry players, both producers and service companies (ExxonMobil, Shell, Sinopec, Total, BP, Gazprom, Schlumberger, Halliburton and Baker) and covers various activities across the entire spectrum of the industry. This increase in spend is influenced by a decline in the cost of internet of things (IoT) sensors, which enables oil and gas organizations to integrate these sensors into their operations along with AI-enabled predictive analytics, thereby demonstrating the marriage between Big Data and AI.

AI and Big Data in Exploration

Seismic surveying, which entails the collecting, processing, and interpretation of data, necessitates the use of advanced computers equipped with significant visualization capabilities. Seismic survey is a critical sector in the industry where AI and Big Data have been successfully applied. Joshi et al. (2018) used artificial intelligence and a lot of data to look at micro seismic data sets and model fracture propagation maps made by hydraulic fracturing. The research looked into whether or not the Hadoop platform, which is a tool for artificial intelligence, could be used to manage the large datasets made by micro seismic equipment instead of more traditional ways of managing data. Using data from exploration, drilling, and production, they figured out what the reservoir was like. This led to a higher success rate because they were able to find anomalies based on what didn't work in the past. This was done by looking at works that had failed in the past (Mohammadpoor & Torabi, 2020).

Total, the French oil major, recently announced a collaboration with Google Cloud to develop an artificial intelligence system for analyzing subsurface data with the goal of optimizing their exploration and production processes. Previously, much of Total's seismic data collection consisted of picture files that scientists painstakingly analyzed. According to Bharadwaj (2019), Total hopes to automate the digitization of this analysis and use AI technology to develop a searchable portal for their staff that can be used to identify trends suggesting potential economic risks associated with a new field. Seismic and subsurface data charts are frequently collected in the form of picture files and require an inordinate amount of time to evaluate manually. Additionally, these data charts are currently saved in a variety of locations, typically on the oil field's premises or in the cloud, in a variety of formats. The following (figure 1) is an example of a seismic data chart (Bharadwaj 2019).

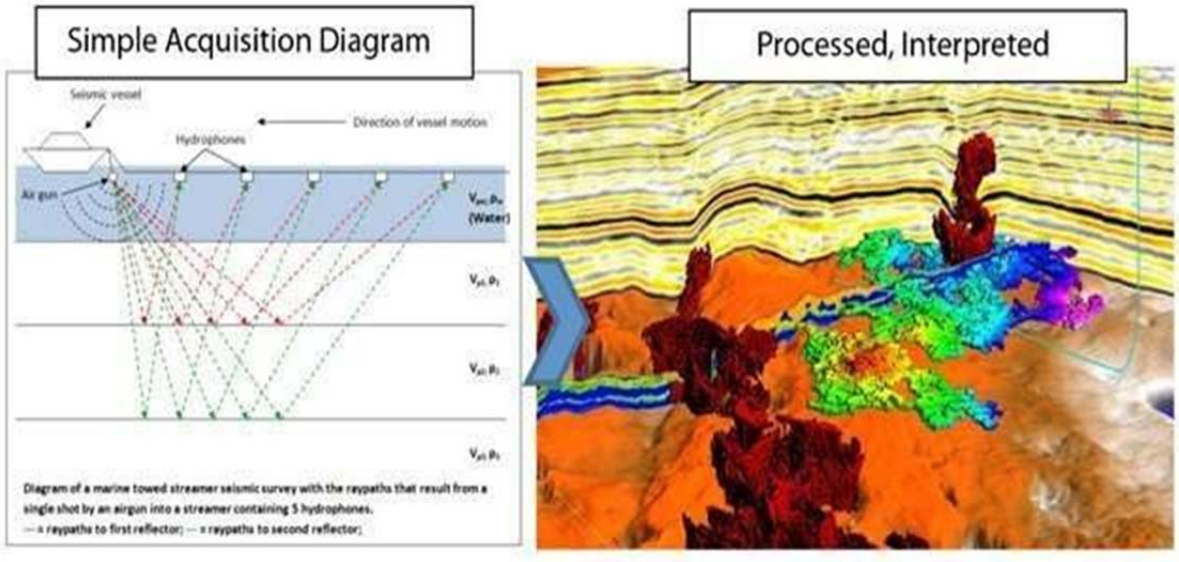

Figure 1: Seismic data chart (Bharadwaj 2019).

Using artificial intelligence (AI) technologies developed by Google and Total, geologists at Total will be able to better understand what seismic studies reveal about the ground. These technologies will be easier to develop with the help of computer vision. An AI assistant that could answer questions about subsurface data in natural language was a key objective of the project's development of software that could analyze image files, match the results with data from technical documentation, and combine all of this information. Working on the project at Google's Advanced Solutions Lab in California are a group of geologists from Total, as well as machine learning experts from Google Cloud. Right now, members of this team are hard at work on it.

By working with MIT researchers, ExxonMobil hopes to automate the process of finding hydrocarbons, Bharadwaj (2019) claims. Deep-water exploration robots and AI software for the robots are being developed as part of this partnership, which will help automate the process of finding and describing natural seeps. Before, oil and gas companies needed a group of geologists and divers to scour the ocean floor for any strange phenomena. ExxonMobil is hoping to keep their workers safe by using a self-driving underwater robot. Machine learning will help these robots collect seismic data, and then they'll use artificial intelligence to find hydrocarbons that naturally leak out of the ground. For oil and gas companies, this will help them reduce costs and save time when searching for new sources of oil and gas.

AI and Big Data in Drilling

The drilling industry is a huge data source, and this includes data generated during well planning and design phases and the ones generated at the rig sites. In a typical rig, there are over 60 different sensors installed at various locations across the rig, recording many parameters throughout the drilling operations. Through the help of AI, some oil and gas companies have been able to process such huge data from drilling operations, which has enabled them improve drilling efficiency through improvements in connection times, flat (non- drilling) times, invisible and non-productive time using real time logging data. In some other instance, some companies have utilized data from downhole vibration sensors to characterize the drill string dynamics by combining actual data with simulation data to develop a drilling automation software (Mohammadpoor & Torabi, 2020). This has helped to reduce the risk of drilling failures, thereby reducing costs (Sumbal et al. 2019).

AI and Big Data in Reservoir Engineering

To gather as much data as possible about reservoirs over time, many companies in the industry have turned to downhole sensor technologies like distributed temperature sensors (DTS), discrete distributed temperature sensors (DDTS), distributed acoustic sensors These sensors include temperature sensors, acoustic sensors, and downhole gauges (Mohammadpoor & Torabi, 2020). PVT analysis, static and flowing pressure measurements, pressure-transient tests, periodic well production tests, daily and monthly production data (for oil, gas, and water), and monthly injected volumes of EOR (enhanced oil recovery) fluids are just some of the uses for this dataset. These measurements and tests are known as "pressure-transient tests" (water, gas, CO2, steam, chemicals). These data are frequently incorporated into AI-enabled reservoir management tools, resulting in a new approach to reservoir modelling based on information. Such data-driven methodologies have the potential to significantly improve reservoir modelling practice by anticipating the effective parameters that theory-based equations of state are incapable of capturing. With the help of artificial intelligence (AI) and big data, reservoir managers have improved carbon dioxide (CO2) sequestration through the prediction of leakage, increased heavy oil reservoir production through SAGD and CSS, and reduced the need for high-cost enhanced oil recovery (EOR) methods. All of these improvements have been made possible by optimizing CO2 sequestration, heavy oil production, and other processes (Mohammadpoor & Torabi, 2020). The over 14,000-well Chevron-run San Joaquin field in California, for example, was the subject of a study led by Popa and Sean (2015). There were numerous logs, temperature and steam readings as well as core data, fluid saturation, and well completion information from these wells. There were also measurements of geological features as well as flow-line temperatures and temperatures at the wellhead. These data were used in conjunction with artificial intelligence to optimize field productivity.

AI and Big Data in Oil and Gas Production

A combination of AI and Big Data is playing a great part in helping organizations achieve what was once thought impossible. Different studies have been carried out by various research teams and institutions to bring about innovations in production engineering and thereby an increase in oil and gas production. Using automated decline curve analysis, Seemann et al. (2013), developed a smart forecasting and flow method that predicts how well Saudi Aramco will do with its production. This was done in order to help Saudi Aramco figure out how to make more of what it already makes. Electric submersible pumps' performance has been improved thanks to the use of big data and artificial intelligence. This was accomplished by investigating issues such as

excessive heat and failed starts (ESPs). To enhance the quality of test results, well data, and SCADA data, big data analytics have been successfully implemented in the industry (Mohammadpoor & Torabi, 2020). Using big data and artificial intelligence, some shale-related companies have improved the efficiency of their hydraulic fracturing operations. There is a correlation between how much proppant is loaded into a well and the distance between stages of fracturing, according to Southwestern Energy, an oil and gas company. For example, Betz and Ockree used Big Data to create AI-based production type curves in 2015 and 2018. In the following years, the field expanded by incorporating these curves into economic analysis. After gathering raw data from both structured and unstructured databases, they ran a series of filters and joins before passing the resulting dataset through a machine learning pipeline for further processing. Their plan had just begun, and this was just the beginning step.

AI and Big Data in Downstream Oil and Gas Industry

In addition to the upstream sector of the industry, Big Data and AI are increasingly being combined to bring about optimization in the downstream sector of the industry. In refinery operations, for instance, some organizations have analyzed and processed historical data to improve petrochemical asset management, leading to a reduction in downtime and maintenance costs. Shell created an artificial intelligence assistant in 2015 for consumers in the lubricant sector of the industry. Typically, clients looking for lubricants and related products must explore a big database to locate the suitable product(s). The Shell Virtual Assistant (SVA) utilizes Emma and Ethan as avatars to assist clients in discovering products through natural language. The SVA operates via an AI-enabled online chat platform accessible via the company's website. The system can provide information such as where to acquire lubricants, the range of available pack sizes, and general information about the technical qualities of certain goods (Mohammadpoor and Torabi, 2020)

To put things in perspective, the company asserts that it's Shell Virtual Assistant (Bharadwaj, 2019):

- Maintains over 100,000 data sheets for over 3,000 products.
- Contains information on 18,000 distinct pack sizes.
- Recognizes 16,500 physical properties of lubricants.
- Correlates Shell items with 10,000 comparable products.

AI and Big Data in Health, Safety and Environment (HSE)

In terms of Health, Safety, and the Environment (HSE), Big Data and AI have been utilized to assist manage risk and enhance safety in the oil and gas industry by analyzing massive data sets of safety occurrences. Certain organizations construct safety predictive analytics using data obtained during safety inspections. This is accomplished by continuously collecting data on safety indicators within organizations and putting them into predictive analytics. The safety indicators that will give the necessary data are behavioral and compliance assessments. In another case, Big Data and AI were used to construct predictive software that forecasts the possibility of hazard events (high H2S concentrations) and operational disturbances occurring during oil and gas production operations (Tarrahi and Shadravan, 2016).

Nigeria Oil Industry: Impact of AI and Big Data

As stated earlier in section 3.0, most of the big spenders in AI and Big Data implementation in the oil industry are the major international oil companies (Shell, Total, ExxonMobil), together with the international service companies (Baker, Halliburton, Schlumberger). Over the years, AI and Big Data implementation in the Nigerian oil and gas industry has been somewhat limited in scope as a result of certain challenges as stated in section 5.0 below. However, the last few years has witnessed an increase in awareness and in the implementation of some novel ideas across the industry which are based on the AI and Big Data concepts. This is driven partly by the presence of the big international players in the Nigerian oil and gas industry and as a response to some peculiar challenges facing the industry locally. The international players have scaled some of the easy-to-implement AI and Big Data innovations listed above in Nigeria while the local players, operators and regulators, are also getting creative with AI-enabled solutions.

One area that AI and Big Data solutions are being implemented in the Nigerian oil and gas industry is in the area of asset integrity (Adekoya, 2019). Most of the assets in the Nigerian industry (flowlines, pipelines, production flow stations, export terminals, refineries, etc) can be classified as ageing assets, as some of them were constructed over 40 years ago. The challenges of

maintaining these assets and getting the best out of them are enormous. At the beginning of the industry, some of the flowlines were laid on surface rather than being buried in the ground, thereby exposing them to unfriendly environmental conditions that have had impacts on their integrity, while some were installed in communities in close proximity to or within living areas, with a higher risk of exposure to interference, theft, sabotage, etc. Additionally, oil and gas infrastructures are highly susceptible to corrosion. Crude oil from different fields usually varies in their chemical compositions and the corrosiveness of the crude also depends on the environment they are stored (Bharadwaj, 2019). The challenge of managing corrosion in oilfield facilities is one of the issues faced by the Nigerian oil and gas industry. Most of the international players such as Shell, Chevron, Total, Exxon, etc. and some local players (Seplat, Aiteo, Eroton) have put in place robust asset integrity policies and programs to manage these challenges while minimizing health and safety risks. For instance, in Shell, there is an asset integrity program whereby the company implements a structured approach of creating, operating, maintaining and decommissioning assets in a cost-effective way. Asset integrity data is being captured on a routine basis, sensors are installed at sensitive points along some flowlines, on pipelines, flow stations to capture useful data and these data is fed into a huge database called Asset Integrity Management System (AIMS). This data is constantly being mined through a smart data processing tool which provides useful outcomes such as: mean-time-to-failure, preventive and predictive maintenance schedules, spares management, amongst others.

In drilling operations, tubular tally (the process of measuring the lengths of each components of pipes that are ran into the wellbore) were traditionally done at the rig site a few hours prior to running those pipes (casing, tubing, drill pipes, fishing assembly) into the well. However, in recent times, with the advancement in Big Data Analytics and Radio Frequency Identification (RFID), most of the big international firms are saving some drilling time and costs by carrying out pipe tally at their logistics base in town before the tubulars are transported to the rigs. In addition to doing the tally offline at the base, some operators have advanced the process further by embedding RFID tags on the tubulars, and with the help of portable hand-held scanners the tally is done in a simpler way by scanning the RFID tags, similar to checking out items in a supermarket and the data is stored and processed electronically in a database. This process creates opportunities for different kinds of analysis to be done on them.

At the Department of Petroleum Resources (DPR), which is the industry regulator, an innovative solution centered on process automation across the industry has been implemented. The DPR came up with two industry solutions that are based on Big Data analytics. The first of these solutions is called Integrated Automated Programme (IAP), which helps to drive collaborations and create a platform for sharing of useful data across industry operators, thereby optimizing their business planning processes. The second innovation is called Oil and Gas Industry Service Permit System (OGISP), which is an industry-wide tool set up to bring efficiency to the process of granting or renewal of licenses to all service companies in the industry (Adekoya, 2019). These are all Big Data-driven solutions that are currently being implemented and they create more opportunities for further refinement when AI is embedded into these platforms.

Drawbacks to AI and Big Data Implementation Nigeria

Operators in the Nigerian oil and gas industry are somewhat behind the curve in terms of adoption of Big Data and AI technologies. This is as a result of some challenges that are prevalent in the local scene. A few of these challenges include lack of a robust industry-wide database where industry players can plug into, the deteriorating security situation in the Niger Delta where operators are not able to operate freely and optimally. Other factors include lack of adequate skilled manpower in the area of AI and Big Data, as this field is relatively new in Nigeria and there is no institution (universities or colleges) offering training opportunities in this field. Also, as a country Nigeria does not have a culture that promotes data capture and mining. Previously, the industry regulator had not made significant effort before now to help promote industry interoperability and collaboration. Collaboration is key in the data age. Oil and gas companies in Nigeria will need to collaborate to share and learn best practices to bring about a successful transformation for the Nigerian oil and gas Industry Damilare, (2019).

The Future of AI and Big Data in Oil and Gas industry

Despite the challenges listed above, the oil and gas industry, both in Nigeria and at the global level, has made a lot of advancement with the implementation of artificial intelligence and Big Data. However, industry experts are of the opinion that what has been achieved so far amounts to scratching of the surface with respect to the potential that AI and Big Data offers the industry. In the future, as the industry captures and processes more data with the installation of more sensors and deployment of more portable data capture devices, there will be an increasing marriage between data analytics and artificial

intelligence, with machine learning and internet of things as new realities. According to Damilare, (2019), the concept of digital twin will become popular, a situation whereby oil and gas companies will create replica of an asset, product or a process, to enable them tests a process before they are implemented in the field. As an example, a reservoir would be exposed to different production pressures virtually before an actual well test operation is carried out, to allow for a faster, efficient well test. A system integration test (SIT) could be done virtually or some critical components of a wellhead system could be exposed to different situations initially to help reduce the cost of the wellhead maintenance.

III. CONCLUSION

This paper has given a broad overview of the impact of Artificial Intelligence and Big Data on the oil and gas industry. The term Artificial Intelligence, which defines a solution that is based on computer systems and can perform tasks that would require human intelligence, but most times would be either too tasking or challenging for humans to perform. Big Data (or Big Data analytics) defines a process whereby a large volume of an available data set is processed in such a way as to aid business organizations or other entities in arriving at an optimal decision making. Big Data has some key attributes called the five V's of Big Data: Volume, Variety, Velocity, Veracity and Value of data, called the five V's of Big Data, which are the critical components that make the concept relevant. The marriage of Big Data and AI has been very impactful in an everyday life: from internet of things (IoT) smart devices to achieving higher efficiency in translations between two languages, from manufacturing of cutting- edge smart robots to processing of historical data and records to aid business executives in arriving at critical business decisions with ability to keep an organization ahead of the competition. In all of these, the oil and gas industry are not left out of the innovation loop. Oil and gas companies are increasingly taking advantage of this emerging technology and the marriage between AI and Big Data to implement innovative solutions to the industry's age- old challenges and to manage the contemporary ones. For instance, AI and Big data technology is being used to achieve increased efficiency and improved results in seismic interpretation with micro seismic data. The goal of drilling engineering is to improve drilling time, cost, and safety by processing and analyzing data from an automated drilling state detection monitoring service (Mohammadpoor & Torabi, 2020). Other areas of impact include analysis of data from downhole sensors using AI technology to improve reservoir characterization and simulation, optimization of production performance, production allocation techniques using data from electric submersible pumps and in the downstream sector in areas such as oil refinery, oil transportation and health, safety and environment. In Nigeria, AI and Big Data application includes some of the solutions listed above and a few additional areas in managing asset integrity, tubular tally for drilling operations using RFID and with the licensing and permit system by the government regulator: Department of Petroleum Resources. Even though E&P companies and the country as a whole are becoming more interested in AI and Big Data, there are still a lot of problems to solve before the idea can be used more effectively in the industry. . Some of these challenges include lack of local skilled manpower, poor data culture, security challenges in the industry's operating areas, limited availability of good quality data, and understanding the complexity of the concept.

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