IoT in the Field of the Future Digital Oil Fields and Smart Wells

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1 Introduction

The IoT has gained its popularity in the global information industry and petroleum explorations industry. The IoT connects everything with the Internet because it is an intelligent network; this helps the devices to communicate and exchange information. What IoT achieves is intelligently, locating, managing, identifying, monitoring, and tracking various things. It is considered an expansion and extension of the Internet-based network, which is the communication expansion from things to things and human to human. Objects that surround people are going to be connected into networks in one way or another in the IoT paradigm. The smart technologies, including, sensor technology, radio frequency identification (RFID) will be embedded in many applications. The evolutions of technology such as storage, battery capacities, and computing power are becoming smaller in size and lower in cost. Hence, this helps developing small electronic devices with capabilities like computing, identification, and communication that can be embedded in other systems, facilities, and devices [1].

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The wireless sensor network (WSN) technology can be utilized in smart oil wells [2]. WSN is a group of sensors for recording and monitoring the condition of a specific environment. Some WSN applications are monitoring pipelines, equipment condition, and natural gas leaks. The system monitors three sectors of the industry and displays reports of the condition of the well. They sense pressure, vibration, pipelines defects, and temperature. The control center receives all of these important parameters and plans for all the steps that need to be taken. Oil theft is prevented because everything is recorded and stored by WSN. The life of the well is extended. The system monitors the holes' pressure that is created to elicit oil and gas from the earth. The high pressure causes the oil to leak, so the system makes sure to avoid that. In addition, the system decides the number of fluids that are needed to be injected inside of the well to displace oil. Furthermore, the system enhances the oil flow through the hoses by mixing it with carbon dioxide and reduces the thickness of the oil. The drawbacks of the system are the wires and heavy tools that cost a high budget and space. The intended solution is a wireless monitoring system and collecting the data remotely and later transmitting to cloud servers to analysis.

2 Literature Review

The Petroleum Analytics Learning Machine (PALM) is a learning-based machine that has a system to manage the gas and oil fields using IoT [3]. PALM has machined analytics applications, which are big-data-centric. It uses computational machine learning as well as predictive and prescriptive analysis techniques to reduce the losses and increase production. The complex machine has smart sensors that bring IoT together to make it a digital oil field. The machine combines artificial intelligence with machine learning to deliver better performance and lower the cost. PALM's software works on utilizing the support vector based machines, which excel the pipeline system performance. In the application, the algorithm functions by open source codes programmed and combined together as tools. The tools hold all of the geological and geophysical attributes that measure the volume of the gas and oil. The data gathering is done by the IoT communication network. The PALM system integration database stores the collected data. Data is processed and cleaned from noise then normalized to be ready for distribution between equipment and tools. The system utilizes codes and boosts the machine neural network. PALM's estimations of the volume and depth of wells are accurate, with low error rate. The distributed control aides in calculations and helps scientists in integrating geology with IoT. The model is still not at its final version as it is constantly developing. The drawback is the integration system, which is not fully successful yet. It is not easy to create a fully distributed network system, which is 100% reliable. The solution to overcome these issues is by designing better sensors that minimize the tasks as much as possible.

Magnetic flux leakage (MFL) is a method to detect corrosion, pitting, and wall loss in steel structures. MFL system works by sensors on the pipelines and detects the different defect types [4]. The targeted pipelines are covered with sensors to measure and collect data. The machine-learning algorithm calculates the parameters that are needed to optimize the performance of the neural network. The financial losses of the pipeline defects are huge, and it will be decreased by using IoT. The intelligent tools locate the magnetic flux leakage with the help of the signals and ultrasonic waves to the pipeline defect. Every defect has a pattern of behavior, and the solution can be applied by studying those behaviors. When the sensor has high axial amplitude, it explains the damage and its size. Several solutions have been suggested, but the most effective one is combining the MFL signals along with artificial neural networks to achieve the maximum reliability and estimate correct results to solve the problem. There is a problem which is the relationship between the depth of the amplitude generated by the signals which cannot always be analytically described. Complexity is an obstacle and identifying the relationship to detect the defects is not easy to implement. The solution could apply a dynamic neural network.

Oil wells need a monitoring system that tracks all the needed parameters [5]. The system consists of layers, and each layer deals with a required task. It has the data acquisition and monitoring layer, then the transmission layer, and finally the data analysis and production management layer. Collecting and processing the data in the first layer is accomplished by the sensors and actuators. They test the power, query locations, and detect temperature. The transmission layer transfers all the data that has been collected by the acquisition layer and managed in a secure channel. 3G, GSM, and ZigBee are some of the technologies, which are used in transferring data. The final layer is the layer that combines the collected and processed data and displays the business model that consists of flowcharts and graphs. It is all done by the network wire protocol. The used algorithm called six Sigma, and its major function is processing the big data. The main issue of the system is the low pressure of the well oil. The system sometimes does not alert the control center, and this will inhibit the daily oil production from increasing. The solution is by inventing an algorithm that calculates the fluids that need to be injected into the pipeline and display the parameters; this algorithm will allow the pressure to go back to normal. Furthermore, the algorithm detects the abnormality of the fluids. Any malfunction should be analyzed and the changes of the parameter should be automatically done.

Big data analytics in petroleum engineering is important because it includes all unstructured and multi-structured data [6]. The collected data are used to develop images of subsurface layers. Extracting gas and oil using drills and exploration became much easier by using IoT technology. The rig transforms into a digital one where the operators finish the job from a distant. The main method is using big data to control velocity, variety, and value. Big data has been profitably used in automated drilling and detecting services. Big data has enhanced the design of smart digital oil fields [7]. Drills and pipeline platforms changed drastically, and the extraction cost reduced. The pattern-based analysis is more desirable to scientists because of the huge impact it has on IoT. Reducing hydraulics and heavy machines is a big goal, which is more likely to be achieved in the next few years. Some information is still lacking, but the researches are still on the path to find solutions and more data processing to reach the maximum accuracy. Data infrastructure in big data analytics aided in the discovery of oil fields. Compromising stacks to get values out of the data. All the processed data include CAD and daily drilling reports. The model faces some technical challenges, such as I/O on the network, fetching shared data effectively, and having multi-label connections. Years of research and progression will solve most of these problems and build an integrated smart oil well, which is automated and digital.

Enhanced oil recovery (EOR) is the recovery of non-extracted oil by natural or enhanced pressure to make it easier to extract. There are three techniques for EOR, which are chemical injection, gas injection, and thermal. One of the old methods that have been used in oil recovery is the thermal method [8]. As expected at this point of evolution of technology, the thermal method is somewhat not practical. Engineers came up with a new method that is much more economical to maintain daily oil production at its best peak. The EOR system deploys advanced IOR technologies that control the field. The major tasks that the system performs are heat injections, solvent injections, and surfactants injections. The main three methods help in recovering oil from rocks. The process of injecting the right amount is complex and has various stages. The findings were quite remarkable. The daily oil barrel production number has increased by 10%. One of the advantages of the method is applying it in the early stage of the life cycle of the reservoir. The technology is still new and still in the development stage. It encountered many issues such as model complexity. Another issue is how harmful it could be to the environment. These issues need to be solved and finding a better correction to the system before commercial use. A large amount of data is processed and analyzed over a high-speed network. The stored large data have different formats as well as different vendors. Sometimes data cannot be traced back, so any carried information might be considered lost. The proposed system model is capable of obtaining the lost data and generating the process of oil extraction. Integrating the mapping of annotations of any dataset is a significant solution. The work focuses now on using domains to integrate seamless data [9].

It has not been a loss to the oil industry when Machine to Machine (M2M), Big Data, and Internet of Things technologies were developed in other areas. It rather has created oil and gas new invention theme, which is known as the digital oil field. Based on Group of Cleantech definitions, the category of digital oil field involves services, related business models, and technologies concentrated in upstream oil and gas activities on the processes and tools for information and data management [10]. Numerous leaders have already worked on their digital oil field initiatives in oil and gas companies' integration; for instance, Shell's Smart Fields, Chevron's Fields, and BP's Field of the Future. Moreover, leaders will carry on looking for new technologies for the sake of decreasing operating costs, as well as increasing output of productions. The term digital oilfield comprises various elements of technology all over the software and hardware solutions, which are circulated everywhere the whole upstream oil and gas activities suite. They are all considered as attempts to provide analysis, transmission, subsequent automated action, and data capture in real time, hence, optimizing performance of production. Nonetheless, the oil and gas section utilize IoT and Big Data concepts to its activities of upstream. Data analysis, communications technologies and networking, and hardware innovations are qualified as new processes of E&P known as the digital oil field.

Smart oil fields have been deployed and proposed for oilfields offshore remotely. Sensors from a wide range included in a smart oil field such as density of gas, temperature, and pressure pipeline, which produce collective data daily on the terabytes' range, require real-time analysis. Solutions of smart oilfield that exist use remote data centers over the cloud and satellite communication, which are not feasible because of significant delay of transfer. A solid allocation model of resource using computing edge is presented as a solution to consider computational capacity with limited connectivity and application intensive resource in the oilfields. The model that is proposed assigns tasks efficiently to a suitable cloud or edge resource to address the constraint of real-time applications in order to obtain robustness. Evaluation of the results displays that the proposed model can upgrade the system performance significantly compared to architectures of conventional based on cloud [11].

There is a limitation to the new oil and gas reserves in recent years, as it is generally spread in environments that are harsh, such as the deep sea, the desert, and the Arctic environment. The activities of production and exploration have an influence immeasurably on the environment. The pressing challenge of the oil companies is, knowing the ways of rationally implementing the existing technology so that the recovery of oil gets improved. The smart oilfield is a method of a loop that is closed asset management, which can achieve data acquisition in real time, monitoring in present, the implementation of the optimization and decision-making, interpretation in real time, oilfield, oil well, and other assets can be connected to one another to assort the management and operation, and thus the effective direction and way to enhance recovery of oil. Recently, with the mature and progress of the monitoring technology of the dynamic reservoir, managing horizontal wells, recovery of oil prospects is improved by the smart oil field. Intelligent oilfield is a complicated system which consists of a process, technology, and people organic combination. Raising the values of the assets through managing reserves of oil and gas in real time and on demand is the final objective. This can be done by reporting and collecting a massive data. Furthermore, under an environment of decision collaboration, timely informed decisions are required [12]. Table 1 shows the different methods used in digital oil fields and the accuracy.

Table 1 Total worldwide oil resources

Resources	% Share of resources
Oil sands bitumen	30
Conventional oil	30
Extra heavy oil	25
Medium heavy oil	15

2.1 Statistics of Oil Reserves, Production, and Consumption

It is difficult to relate the resources of oil in all the worldwide; this is because there are several areas around the world which are still not fully known geologically and unexplored by drilling. As shown in Table 1, oil sands bitumen represent 30% as well as conventional oil. However, the extra heavy oil represents 25%, while medium heavy oil only 15% [13].

The universal competition for producing oil has increased in the last decade. Many industrializing countries entered this field, including India and China. However, some nations are still in the top globally such as the USA, which represents 18% of worldwide oil production. Followed by Saudi Arabia 12%, Russia produces 11%. Canada and China account for 5% of global oil production. Table 2 shows the top 5 oil producing countries [14].

According to the energy information administration (EIA), the total amount of crude oil consumption worldwide is about 93 million barrels per day. [15]. The USA is the largest consumer of crude oil with 20% of world consumption, which is equivalent to 19.69 million barrels per day. China is the second consumer country after the USA, and it represents 13% of worldwide oil consumption, with 12.79 million barrels per day. After that, India and Japan have convergent values, 5% and 4.44 million barrels per day for India, yet 4% and 4.01 million barrels for Japan. Russia represents also 4%, but with 3.63 million barrels. Table 3 shows the top 5 oil consumption countries.

Table 2 Top 5 oil producing countries

Country	Million barrels per day	% Share of world's total production
USA	17.87	18
Saudi Arabia	12.42	12
Russia	11.40	11
Canada	5.27	5
China	4.82	5

Table 3 Top 5 oil consuming countries

Country	Million barrels per day	% Share of world's total production
USA	19.69	20
China	12.79	13
India	4.44	5
Japan	4.01	4
Russia	3.63	4

3 Current Methods for Oil Fields Management and Drilling

Large companies leverage the usage of intelligent processes and technologies in drilling oil fields to achieve their strategic goals. The first method to manage the smart oil fields is creating intelligent field centers to make decisions in a collective way. To ensure the success of these centers, a project methodology should be followed. The methodology should start with ensuring a clear understanding of the intended plans and it concludes with maintaining continuous improvement. The methodology has five stages, which are assessment, design, construction, implementation, and continuous improvement as shown in Fig. 1. In the assessment stage, the teams that will be working on the project and the stakeholders will determine the requirements. In this stage, the activities and workflows including the need for software, hardware, data, and visualization will be defined. In the design stage, there can be an improvement. The construction stage includes testing and installing the hardware and software as well as the other infrastructure that will be needed in delivering the reservoir performance and technical planning workflows. The stage embraces the civil and mechanical task aspect of the environment, such as electricity and lighting. The defined work plan, associated software, and infrastructure will be customized in the implementation stage. This will need defining the technical aspects such as software integration, process implementation, and process optimization as well as the human aspects such as cross-domain integration and training. Finally, the continuous improvement stage will include regular meetings to follow up with the workflow. Those meetings will help the reservoir management engineers to understand the problems and provide the best solutions and recommendations to solve them [16].

The management system of oil industry shown in Fig. 2 consists of some fundamentals and elements divided into two independent components. The fundamentals focus on the most important management principles to have an efficient and

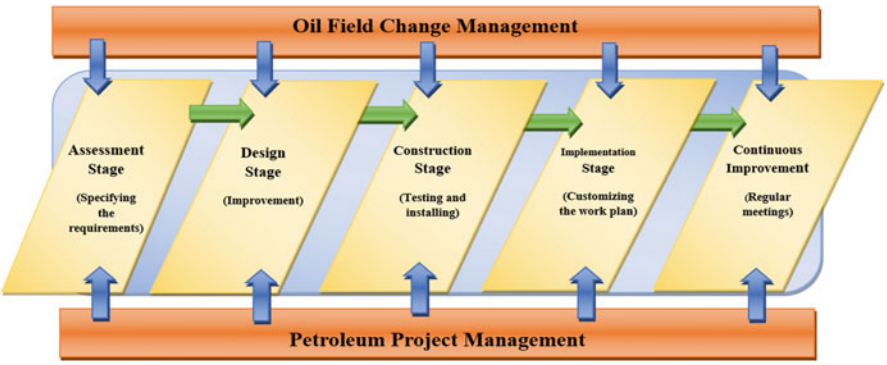

Fig. 1 The stages of intelligent field centers

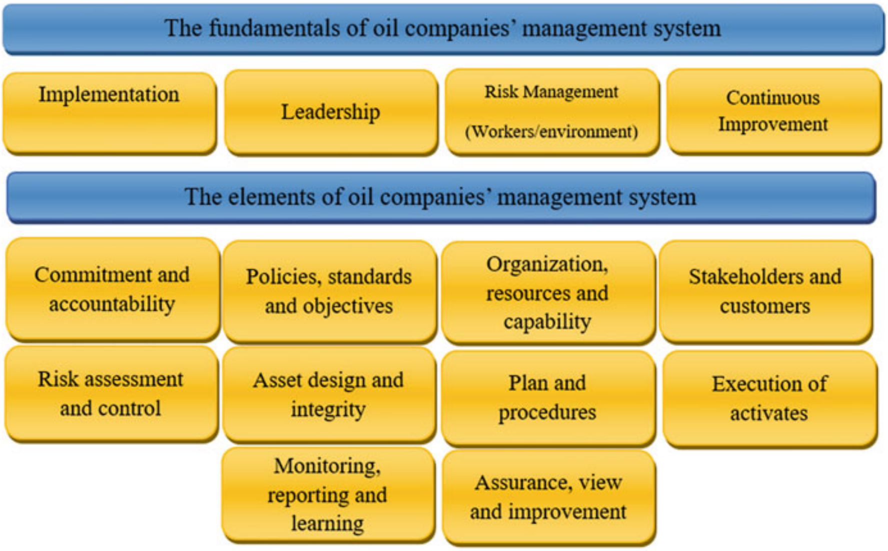

Fig. 2 The fundamentals and elements of management systems

Fig. 3 The requirements of oil and gas management system

effective management system, which are leadership, risk management, continuous improvement, and implementation, such as well drilling. The ten elements include a set of exceptions and overviews that define the system's best outcomes [17].

Oil companies seek to achieve the International Organization for Standardization certifications (IOS). ISO 29001, requirements shown in Fig. 3, defines the Quality Management System for the companies that work on designing, developing, producing, and installing petroleum products. ISO 29001 standards highlight the requirements of the companies to have an effective and efficient Quality Management System. The first requirement is proving the ability to provide products that meet statutory/regulatory and customer requirements. The second requirement is enhancing customers' satisfaction through many improvement processes and providing requirements that meet their needs. The third requirement focuses on preventing defects and reducing waste. Achieving the certification assists in showing the commitment to industry best practices and managing operations effectively [18].

4 Challenges in Oil field Management Systems

The IoT is still in its early stages, which is because of the many challenges that hinder the future growth. The main obstacles include the lack of skilled workers, lack of theory, and lack of systematic research for reaping the benefits [19]. Distributed intelligence designs are limited and there are many problems that need to be solved regarding the sensors, cameras, power nodes, and identification. One of the main challenges is the architecture [1]. Data integration in different environments is tough due to changes in the earth's layers or between devices. The system has to combine different sources in order to determine which feature to use, how to extract the oil, what drill to use, and how to determine the depth. The technology has to be fully functional for every environment and for all cases. RFID technologies differ as well as wireless networks. Different requirement for each communication can take time and be costly.

Sometimes the unnecessary dependencies are going to blackout the migration of connecting as many things together. Introducing a successful platform requires successful hardware and here lays the challenge. The systems have to be in a minimum size and lightweight with a wireless identifiable system. Some levels diverge because they go from kbps to mbps. It is a challenge to have an ultra-cost with low-powered hardware because when the system is on sleep mode, it will not be able to receive the RF signals and it will cause an economic loss. The system cannot combine all the features together; low cost, low power, and size with integrated data could be a challenge as well [19].

Another challenge is privacy and security. It has to exceed traditional security methods because the system deals with oil. The challenge is designing a secure system, which is capable of doing all the tasks as well as maintaining a high level of security. In addition, the system has to analyze the oil parameters and transfer the data between the platform and the terminal through the connection protocol. It could be a challenge to minimize and achieve the desired level of accuracy because all of the objectives are still in the developing phase. The challenge could be in the routing process, which is selecting the best path for data movement. The best path can be chosen based on the number of hops, bandwidth, and costs. Another problem is big data, which is massive data, whether unstructured or structured. The dataset could be big data when it meets the four V's, which are volume, variety, velocity, and veracity. It is hard to deal with it by using traditional software techniques and database methods. An example of big data could be a huge amount of data collected from deploying sensors [20].

5 Improving the Functioning of the Oil and Gas Industry with IoT

The oil and gas industry face many obstacles, which should be eliminated in order to enhance oil and gas production and getting higher revenues. In the meantime, the IoT started to enhance the operation of the oil and gas sector globally. The Internet of things has a big influence; this is because it helps to get rid of many problems the oil and gas industry face. According to [21], there are many techniques that will help to revolutionize the oil and gas industry, which includes the preventative maintenance for remote oil and gas equipment. This will help the large oil companies to monitor the wells more easily. For example, a company that monitors more than 50,000 wells will spend the big amount of money on the equipment. Furthermore, a single malfunction in any of the machines will cause slow production. The IoT technologies help in equipment maintenance and protect the equipment. This is because the IoT device can be deployed to remotely monitor equipment. This will limit losses as well as increase the production. Also, improved operational efficiency, which means the big data analysis and remote visibility will support the companies to manage their assets and use their findings to optimize production. In addition, real-time data, which will help to capture the oil production in real time through the embedded sensors will help the companies to collect the needed information related to the oil fields from anywhere in the world. The wide adoption of IoT could raise global GDP. Moreover, fewer safety risks, the Internet of things could minimize the risk that could show up as a result of potential issues in the oil industry field. The real-time data, will help to capture the oil production in real time by the embedded sensors. Figure 4 shows the proposed organization of smart wells.

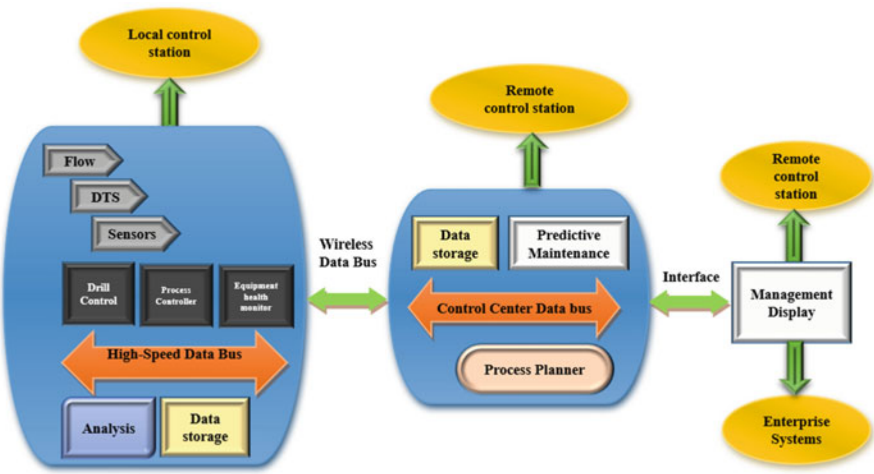

Fig. 4 Proposed organization of smart oil wells

Since the appearance of Internet of Things (IoT), many industries have been practicing and applying its technologies and concepts. Industries have also been driving IoT security efforts and standardization. A new concept on Industrial Internet has evolved from the integration of IoT in many industries. The Industrial Internet Reference Architecture (IIRA) has been recently published with standards for the integration of IoT in industries. Industries like the oil and gas industry can utilize the full capability of the IoT within the processes of upstream and downstream. There is a growth in terms of system integrators and device suppliers' ecosystem. There are protocols, protocols of communication more specifically, interfacing one to another for the sake of integrating seamlessly like Data Distribution Service for Foundation of OPC. In addition, there is a chance to implement the maintenance and improve the safety to have better production, as well as enhance operations by extracting helpful guidance from the developed case studies. A severe cut of cost and a widespread time investment are required for these initiatives, which can be a key to automating tasks of intensive labor, dilating operation of remote, and lowering cost of production, which all participate in the bottom line. The main challenge is security however, this issue hasn't been ignored and the appropriate methods do exist. Data residency is another big challenge because it is a technical issue but at the same time legal and political, many regions will find it too difficult to remove.

Oil and gas organizations are considered very complex. Volumes of data with business are exponentially expanding but bounded by the data quality, IT systems traditions, and ability of staff. As the technology of big data has been developing lately, the big data capabilities benefit oil and gas organizations to perform analysis on data under large volumes, transforming reactive to proactive in decision-making, and optimizing the whole development, production, and exploration phases. The forum of world economy in 2011 suggested that the new economic oil is Big Data. Furthermore, technology on big data in gas and oil industry is an ongoing stage of experiment. The sizable data application is beneficial in terms of breaking through the leaders of oil and gas companies' bottleneck development which almost all leaders of the oil companies believe. Moreover, they recognized the value technology of big data on restructuring the industry. The big data is a set of complex and huge data, which is a field that analyzes information and deals with large and complex data. This will help to deal with the software applications of processing traditional data. Thousands of sensors are used by oil and gas companies that are installed in facilities' surface and wells subsurface in order to provide continuous conditions of environment, collecting of data, and assets real-time monitoring. In development and exploration, professionals execute operational and strategic tasks in making decisions with the support of analysis of large data. For instance, in terms of data of real time, new insights can be delivered by the company that can enhance efforts of exploration, which is considered a big help for operating teams. Based on real time and historical data in terms of production, future performance can be predicted by big data. Based on the collected data, equipment of maintenance, big data can support to restrain down time and to structure a model for predictive maintenance in oil and gas companies. Figure 5 shows the oil and gas industry big data conceptual architecture.

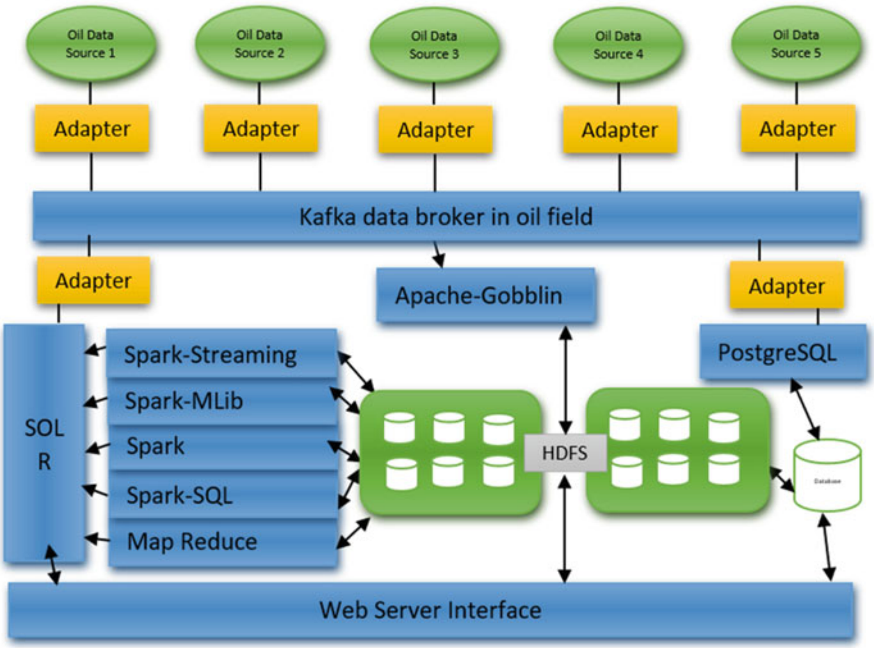

Fig. 5 Oil and gas industry big data architecture

A system for improving the drilling process could be a good example of using IoT in drilling oil fields. The first part of the system maintains the used equipment and speeds up the process of requesting new devices. It monitors the level of oil. When an error occurs, the system will be turned off automatically. Those errors will be detected by sensors, which collect data from the field, such as oil value, oil low value, oil very low value, oil high value, oil very high value, and oil set point. In the system in Fig. 6, LT refers to the level transmitter while LC refers to the level controller; PC refers to the pressure controller while PCV refers to the pressure control valve. Finally, XV is the shutdown value. The second part is the thin client application. This part provides many services such as determining the initial values, viewing the values of gas and oil, the timer of reading the sensor, and a web application that enables the users from monitoring the system from any place. The web application has various types of users, such as engineer, operator, and manager. The administrator will assign the privileges for users based on their responsibilities.

Development and economy of cities dependent on oil industry are confronting at present extreme social, environmental, and economic issues. These cities industrial structure has a comparatively traditional pattern of industry, which are based on petroleum and intensive petroleum economy with relatively low efficiency and technology levels. Metropolises in China have stepped inside smart cities in the widest range, and cities that are based on petroleum are still lagging behind.

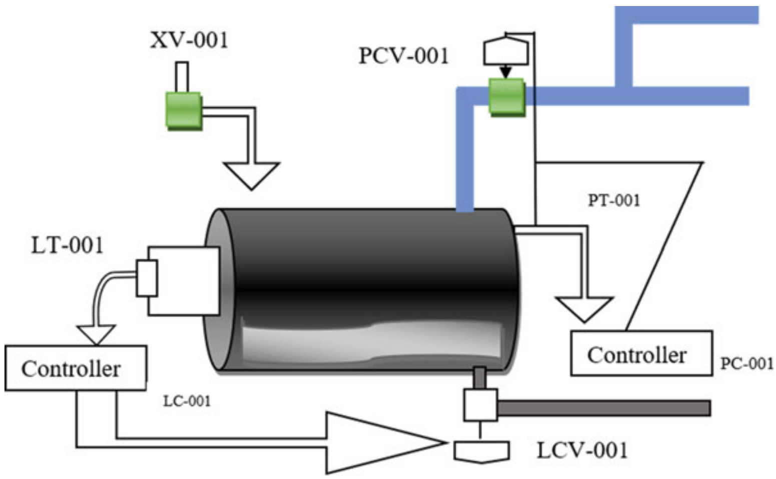

Fig. 6 Proposed IoT Sensors based system state for drilling oil fields

Hence, metropolises in China have good environmental and economic potentials, especially in the energy field, yet, with stage of depletion metropolises must show conditions of living favorably. Cities based on petroleum evolving into smart cities under the development of smart city trend are inevitable. However, oilfield-based oil exploitation as the fundamental service of cities based on petroleum drives economic development. Development of smart oil field is therefore the transference of cities based on petroleum key point. The idea of digital oil field is where the smart oil field concept evolves. The digital oilfield core is networking and digitalization that underlines collection of data. Smart oilfield presents human and artificial intelligence by contrast, hence, underlining their integration and focusing on sharing knowledge, managing intelligence, making decisions scientifically, and mining data. A developed smart oil field future reference is provided. Harmonious, green, efficient, and intelligent are the conclusion of the development of smart oilfield targets [22].

6 Benefits of IoT in the Oil Field

There are many benefits of IoT including: comprehensive perception, obtaining data and information from any spot by using sensors, two-dimensional barcode, and RFID. This could make the communication systems and information be invisibly embedded in the environment. Workers will be able to interact with the machines using sensors network. Location and objects identifications are considered as identification technologies. To implement overall perception, it is required to have recognition and identification of the physical world. Using sensors such as gas pressure sensors and gas pressure switches caused a notable improvement in the safety and security of workforce, assets, and operations.

Reliable Transmission: Objects' information can be available at any time through different types of available telecommunication networks, the internet, and radio networks. Switching technologies, gateway technologies, networking technologies, and wired and wireless transmission technologies are types of communication technology. In addition, IoT creates machine-to-machine (M2M) interaction, which is considered as the main implementation technology of the Network of Things. M2M innovations have been used in the petroleum industry to maintain the health of workers from life-threatening activities and to increase the production of gas and oil. Furthermore, M2M interaction enables the communications and connections between M2M, human to machine, and mobile to machine.

Intelligent Processing: Several technologies that deal with intelligent computing such as cloud computing, which supports IoT data applications by gathering IoT data and placing them in a form of databases. The cloud technologies allow the workers to monitor the system effectively to prevent accidents such as gas leakage. The connected systems can be programmed to send an alert to all the devices in the system when it begins to fail.

Cost Reduction: More than $100 per barrel of longstanding oil price has led to even higher increase in oil prices throughout the years. According to Hamilton, supply in fresh sources opened up by technologies of new extraction, which suggests $20–$30 less per barrel as equilibrium of a new price. Lowering oil prices is beneficial in terms of exposing the inefficiency of oil and gas companies as well as leading the efficient companies to find their ways of preserving the bottom and top lines. The new suite of technologies engages in giving companies a hand to deal with these challenges, which is good for both gas and oil industries. IoT has been simmering for a while, which basically integrates analytics, communications, and sensing capabilities. At any point it will boil over, which means the improvement of the core enabling technologies are expected to reach a point where the adoption of widespread of core enabling technologies seems more likely. The promise of IoT does not include the assistance of Oil and Gas companies in managing their customer relationships supply chains or existing assets. As a matter of fact, a new asset of information businesses concerning these elements was entirely created by IoT technology. Therefore, there is no wonder that the one-size-fits-all IoT solution came up. Operations optimization, new value creation, and reliability improvement are the three business objectives the oil and gas industry has related to the deployment of IoT. In one of these three objectives, every oil and gas segment could be able to discover the benefit of the IoT initial efforts and new information sources, which can enable them. Production and exploration are examples of upstream organizations, which concentrate on optimization. It examines various groups of cross disciplinary, physics, and non-physics data. Storage, pipelines, and transportation are examples of midstream organizations that concentrate on opportunities of new commercial and integrity of higher network, which aims to designing an infrastructure of enabled data to discover certain benefits.

7 Conclusion

The IoT has progressed in the previous 10 years; this includes the huge improvement in oil field industry, which resulted in changing the gas and oil industry remarkably. The tasks became automated, faster, and economically much more conserved, which helped to increase the daily production. IoT is changing the oil industry and extraction techniques and turning it into a whole new level of technology evolution. The integrated network and machine learning models in smart wells overcame all the obstacles and struggles that scientists had been facing. In the near future, it is possible that robots are going to replace the operators in the control center of rigs and oil fields. This will help to improve the overall functions that relate to oil field. The new intelligent systems are going to be capable of doing all the necessary functions to extract oil, detect the right amount needed to inject and measure all the volumes, and generate full reports of the results.

References

1. Bandyopadhyay, D., & Sen, J. (2011). Internet of things: Applications and challenges in technology and standardization. *Wireless Personal Communications, 58*(1), 49–69.
2. Mohamed, A., Hamdi, M. S., & Tahar, S. (2015, August). A machine learning approach for big data in oil and gas pipelines. In *2015 3rd International Conference on Future Internet of Things and Cloud* (pp. 585–590). IEEE.
3. Carvajal, G., Maucec, M., & Cullick, S. (2017). *Intelligent digital oil and gas fields: concepts, collaboration, and right-time decisions*. Oxford: Gulf Professional Publishing.
4. Anderson, R. N. (2017, December). 'Petroleum Analytics Learning Machine' for optimizing the Internet of Things of today's digital oil field-to-refinery petroleum system. In *2017 IEEE International Conference on Big Data (Big Data)* (pp. 4542–4545). IEEE.
5. Aalsalem, M. Y., Khan, W. Z., Gharibi, W., & Armi, N. (2017, October). An intelligent oil and gas well monitoring system based on Internet of Things. In *2017 International Conference on Radar, Antenna, Microwave, Electronics, and Telecommunications (ICRAMET)* (pp. 124–127). IEEE.
6. Xu, B., Wang, W., Wu, Y., Shi, Y., & Lu, C. (2017, March). Internet of things and big data analytics for smart oil field malfunction diagnosis. In *2017 IEEE 2nd International Conference on Big Data Analysis (ICBDA)* (pp. 178–181). IEEE.
7. Mohammadpoor, M., & Torabi, F. (2018). Big data analytics in oil and gas industry: An emerging trend. *Petroleum* (In Press). https://doi.org/10.1016/j.petlm.2018.11.001.
8. Kokal, S., & Al-Kaabi, A. (2010). *Enhanced oil recovery: challenges & opportunities*. World Petroleum Council*:* Official Publication, 64.
9. Chelmis, C., Zhao, J., Sorathia, V. S., Agarwal, S., & Prasanna, V. (2012, January). Semiautomatic, semantic assistance to manual curation of data in smart oil fields. In *SPE Western Regional Meeting*. Society of Petroleum Engineers.
10. Reece, C. A., Hoefner, M. L., Seetharam, R. V., & Killian, K. E. (2008, January). An enterprise-wide approach to implementing 'digital oilfield'. In *Intelligent Energy Conference and Exhibition*. Society of Petroleum Engineers.
11. Hussain, R. F., Salehi, M. A., Kovalenko, A., Salehi, S., & Semiari, O. (2018). Robust resource allocation using edge computing for smart oil fields. In *Proceedings of the International Conference on Parallel and Distributed Processing Techniques and Applications (PDPTA)*, Las Vegas, pp. 204–210.
12. Hao, X. (2013). Intelligent oilfield work processes-turning data into effective decision and actions. Master's thesis, University of Stavanger, Norway.

13. Hendricks, T. A. (1965). Resources of oil, gas and natural-gas liquids in the United States and the world. *United States Department of Interior, Geological Survey Circular, 522*.
14. Dale, S., & Fattouh, B. (2018). Peak oil demand and long-run oil prices. *Energy Insight*, p. 25.
15. U.S. Energy Information Administration. Retrieved from https://www.eia.gov/tools/faqs/faq.php?id=709&t=6
16. Barghouty, M. F., Al-Dhubaib, T. A., Jama, A. A., & Jaimes, O. (2010, January). Intelligent field centers (IFCs): Integrating people, processes and technologies to optimally manage giant fields. In *SPE Intelligent Energy Conference and Exhibition*. Society of Petroleum Engineers.
17. Qu, T., Thürer, M., Wang, J., Wang, Z., Fu, H., Li, C., & Huang, G. Q. (2017). System dynamics analysis for an Internet-of-Things-enabled production logistics system. *International Journal of Production Research, 55*(9), 2622–2649.
18. The International Association of Oil and gas Producers. (n.d.). *Management systems*. Retrieved July 25, 2019, from https://www.iogp.org/oil-and-gas-safety/managementsystems/
19. Gilchrist, A. (2016). *Industry 4.0: the industrial internet of things*. New York: Apress.
20. Ali, Z. H., Ali, H. A., & Badawy, M. M. (2015). Internet of Things (IoT): definitions, challenges and recent research directions. *International Journal of Computer Applications, 975*, 8887.
21. Tao, Z. (2010). IOT's Application in the "Digital Oil Field". *Telecommunications Science, 26*(4), 25–32.
22. Liu, H., & Ma, X. (2019). Smart oilfield development and transition of petroleum-based cities. *Frontiers of Engineering Management, 6*, 299–301.

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