Journal of Quality Engineering and Production Optimization

Volume 9, Issue 1, Winter & Spring 2024

http://jqepo.shahed.ac.ir

Research Paper

DOI: 10.22070/jqepo.2024.16451.1239

Data management in upstream industries and supply chain and value chain: A collection of theories in the oil and gas industry

Atefeh Hasan-Zadeh [1*], Yousef Kazemzadeh [2], Mohsen Fathi Aghbolagh Mostafakhan [3], Ali Amiri Ghazghapan [4]

[1] *Fouman Faculty of Engineering, College of Engineering, University of Tehran, Fouman, Iran*

[2] *Department of Petroleum Engineering, Faculty of Petroleum, Gas, and Petrochemical Engineering, Persian Gulf University, Bushehr, Iran*

[3] *Department of Chemical Engineering, Chemical and Petroleum Engineering, Sharif University of Technology, Tehran, Iran*

[4] *Department of Petroleum Engineering, Fouman Faculty of Engineering, College of Engineering, University of Tehran, Iran*

**** Corresponding Author:*** *Atefeh Hasan-Zadeh (Email: hasanzadeh.a@ut.ac.ir)*

Abstract *–The present paper explains the qualitative reasons for the importance of data management in upstream oil and gas. It also provides small and concrete examples in which data management can effectively increase value creation in this sector. From another perspective, the rapid evolution of supply chain management as a subset of operations management shows that companies no longer compete in the value chain. The role of data management in drilling as an essential member of the supply chain and refining as the most important common member in the supply chain and value chain, along with the application of data-driven economics and management knowledge, have been investigated in this study. The results showed that in addition to the need of upstream and downstream parts of the oil industry for data collection and analysis, the collected data must meet these conditions: it must be collected at the right time, the appropriate field for data collection must be selected, enough volume of data must be collected, data collection must have suitable collection velocity and finally, the data needs to be updated. In this way, the company can provide the necessary grounds to obtain reliable results.*

Keywords*– Data Management, Upstream Oil and Gas Industries, Data Risk, Supply and Value Chain, Data Analysis.*

I. INTRODUCTION

Today, data is considered a valuable resource and asset, and the need for data and its generation in time and the appropriate amount and quality is an inevitable issue in all industries and business environments (Jayagopal and Basser, 2022). Data consists of a set of raw, discrete symbols, words, numbers, and facts obtained by observing, calculating, measuring, and experimenting to represent events. Rawness means that data does not produce meaning on its own; it can be characterized as objective and abstract facts about events that do not indicate their relevance, irrelevance, and importance (Salehi and Ahmadi , 2019).In an article entitled "From Data to Wisdom" in 1989, Ackoff presented a hierarchy of data and information, whose generalities are agreed upon in the knowledge and wisdom of scientific

Manuscript Received: 14-November-2023 & Revised: 16-January-2024 & Accepted: 16-April-2024
ISSN: 2423-3781

sources (Ackoff, 1989). Accordingly, data constitute the first level of data and knowledge management and are the basis for generating the information and knowledge needed in decision-making and the formation of wisdom. Information, which Peter Drucker defines as relevant, purposeful, and meaningful data, is at the next level and requires knowledge to convert data into information (Drucker, 1998; Frické, 2018).

Knowledge is the combination of thinking with information and represents an individual’s interpretation of information based on personal experiences, skills, and abilities. Information becomes knowledge when interpreted by individuals, mixed with their beliefs and commitments, and given meaning. Wisdom is the final element in the pattern of knowledge production. Rowley's definition of wisdom attributed to Ackoff is "the ability to increase productivity and produce added value through mental performance and intelligent judgment" (Rowley, 2007).

In the upstream oil and gas industry, as in other industries, the limited resources available for obtaining data optimally, in terms of time, financial, economic, and feasibility, have led to the creation of a new science in this area called "data management" (Nguyen et al., 2020). There are several definitions for data management, including definitions that are well consistent with the goals of the upstream oil and gas industry: designing policies, systems, and methods to identify and control data needs, obtain that data in a timely and economical manner, ensure the appropriate amount of data for a specific use, distribute or relate data to the place of application, and analyze the type of application in the upstream oil and gas industry (Bhattarai et al., 2019; Marins et al., 2021).

The supply chain is a system consisting of organizations, individuals, activities, information, and resources that are available for supplying a product or service to the consumer. Supply chain activities include the transformation of natural resources, raw materials, and their components into a final product delivered to the end customer (Kozlenkova et al., 2015). The products used in complex supply chain systems, may enter the supply chain wherever residual value is recyclable. Furthermore, supply chains link value chains (Nagurney, 2006). In the 1980s, the term “supply chain management” (SCM) was developed to express the need to integrate key business acquisition processes through essential suppliers (Oliver and Webber, 1982). The main idea behind supply chain management is that companies place themselves within the supply chain by exchanging information about market fluctuations and production capabilities (Sees, 2013; Blanchard, 2010).

Data management can be the missing link between the production and acquisition of data by technical people, on the one hand, and their aggregation and storage in upstream information systems, by statistics and information technology experts, on the other hand, for effective and useful application by final users. What is essential here is to instill the spirit of data management within these processes (Geekiyanage et al., 2021; Tan et al., 2022; Montenegro et al., 2021).

Nguyen et al. (2020) investigated that with the help of data recording sensors in the oil and gas industry, enormous amounts of data have been recorded, creating a valuable source of data. To convert this data into information and useful knowledge for decision-making at the level of senior managers, the need for data analysis and evaluation has been proposed. This research introduced Big Data Analysis as a powerful method to be used for the optimization of production systems in the oil and gas industry.

Integration is the action of effective supply with practical information sharing for improving supply chain performance. A company achieves high corporate performance only when management teams both emphasize technology investment and select the appropriate information to share. Operational and managerial data have a direct effect on the members of the supply chain and value chain, impacting their management.. Proper analysis of all operational and managerial data is essential to improve supply chain and value chain performance and is a basic need of the oil industry.

Following the introduction of different sectors of the oil industry, their products and applications, an examination of the supply and value chains, and the role of data mining in supply chain management are the main parts of this paper.

The key points of this study have been summarized below:

- The importance of the need for data and the effect of data shortages or absences on uncertainties in project management, benefits, and other topics like process safety and sustainable development.
- The impact of data review and analysis on short- term and long-term planning for a project.
- Discussion of successful and reliable methods in data analysis and project management called “Quantitative Data Value and Data Management” introduced by NOAH Co. in three parts: data cost, data value, and data risk.
- Introduction to one of the successful departments in the field of upstream and downstream active data management in the oil and gas industry.
- Introduction to supply and value chains, with a discussion on data management for drilling and refining which are important components of these chains..
- Discussion on the definition of data-based economics and management knowledge.

The optimal use of data obtained from drilling and refining, two main members of the supply and value chains of the oil and gas industry, is one of the main topics of this article, which is very important for management at the senior section. This research examines how the lack of use of available and reliable data reduces efficiency in both sectors. On the other hand, data usage helps senior managers of the organization adjust their long-term strategies based on the knowledge gained from information analysis to increase the productivity and profitability of the organization.

II. UNCERTAINTY CAUSED BY LACK OR ABSENCE OF DATA AND ITS ECONOMIC EFFECTS

Uncertainty refers to a situation in which knowledge about an event or process is limited, and it is not possible to accurately describe its current state. Due to the uncertainty, it will be difficult to judge the performance and make the right decisions about an event or process. In general, the uncertainty that leads to risk is due to the lack or absence of data, information, and knowledge. There are levels of uncertainty in each sector of the upstream value chain; for example, uncertainty in a hydrocarbon reservoir reflects a lack of transparency about the status of that reservoir and the results associated with its production performance. Consequently, managing the reservoir and making the right decisions about it will be associated with risk.

The most important source of uncertainty is the scarcity and lack of data or its inadequate scale and quality. For example, the data obtained directly from reservoirs is mainly related to areas of the reservoir where wells have been drilled. Some of this data comes from cores, which represent a volume millions of times smaller than that of the reservoirs, although they have high accuracy. As a result, generalizing these measured values to the entire reservoir is challenging. Elsewhere, seismic information may have high and good coverage but low resolution and accuracy. Therefore, it cannot predict the future behavior of the reservoir based on this data and information.

Due to the increasing effect of uncertainty, the less and later attention is paid to this issue, the greater the risk of uncertainty in the later stages of the upstream value chain, and hence, it will impose significant economic costs on activities. For example, incorrect estimation of oil extractable from a reservoir can lead to faulty design of the size of surface facilities and inaccurate determination of the number of wells to be drilled (Shafiei et al., 2013).

An estimate higher than the actual value in such a case would result in the commissioning of surface facilities with high processing capacity and the drilling of more wells. Considering that the cost of building surface facilities is estimated in the millions of dollars and that each onshore oil well typically costs between 8 million $ and 12 million $ and offshore oil well costs between 25 million $ and 50 million $, it is observed that the existence of uncertainty in the amount of extractable oil can lead to economic losses ranging from tens to hundreds of millions of dollars. Such examples further show the importance of reducing uncertainty by providing and producing data at the right time and in the right amount. Of course, on the other hand, since data acquisition requires spending, it is essential to consider the optimal point for data acquisition in an economic framework and to take into account the added value resulting from the data obtained throughout the reservoir life cycle.

III. THE NEED FOR PLANNING TO MANAGE DATA

During various activities related to the upstream value chain, obtaining more or less data may be possible depending on that activity. Therefore, it is possible to generate data for different activities in this chain. For example, large data such as porosity, permeability, relative permeability, and saturation percentage, etc. can be measured on core samples taken from a well. Given this frequency and diversity in data type, as well as in the number and location of samples, planning to manage and control the volume of data; on the one hand, prioritizing the acquisition of important data, and avoiding unnecessary sampling, on the other hand, shows its importance and necessity.

In addition, if data is not obtained at a specific time and place, it may either become impossible to obtain at a later stage or, if it is available, it will cost more. An example of such a situation occurs in well-logging operations. Most well-logging diagrams are usually not repeatable after wall pipe installation, so they must be taken before walling. Some diagrams, if not obtained while the well is open as a hole, expensive technologies, such as electrical resistance measuring instruments in wells with wall pipes, must be used to obtain data after walling, which increases the cost of operation. As another example, we can mention the plans and projects for underground carbon trapping and injection, as well as underground natural gas storage.

To evaluate the natural, technical, and economic feasibility of a dry geological structure or a depleted oil or gas reservoir for the implementation of such projects, critical data is required. This includes caprock resistance of that reservoir to the injection gas pressure, cohesion and proper dependence of the caprock according to its permeability, sufficient volume of the reservoir, acceptable permeability of the reservoir rock, injectability, and optimal deliverability (Azin et al., 2008).

Suppose this data is taken in the initial phases and during the presence of the rig and equipment at the wellhead. In that case, the significant difference in cost becomes quite noticeable compared to the situation in which it is obtained after reservoir discharge and leaving the rig and equipment.

This requires predicting such applications and planning to obtain the data they need to capture this data during drilling at a much lower cost and time compared to the above case.

The above examples illustrate that data may have unpredictable importance and value over time. It may seem that the life of an oil or gas field or reservoir ends with its extraction time, but new needs and emerging technologies make it possible to use more than one reservoir, even after discharging it. If a reservoir later becomes a candidate for projects such as carbon storage or gas storage, the data taken over its extraction lifetime will be revalued and unpredictable, provided it is valid. This is also the case when it is possible to reproduce from the field with the advent of new technologies. Therefore, benefiting from a reservoir and field data in unpredicted future uses requires, firstly, maintaining and planning for their acquisition, and secondly, maintaining them in a secure, coherent, and classified manner. More accurate planning for the acquisition and storage of data for the future horizons of a reservoir, which includes the times after its discharge, will increase the economic and temporal benefits of this data in future projects.

Optimal data points in terms of dispersion number, and resolution are also one of the necessities of planning for data acquisition. For example, in the operation of coring a well or plugging a complete oil core, the number, location, and distance of the cores or plugs for subsequent measurements should be optimized according to the type of reservoir rock. Additionally, due to the high cost of 3D and 4D seismic operations compared to conventional 2D operations, it must be studied whether this operation can create added value against its high cost by better describing the reservoir. Time constraints are only one of the limitations on data acquisition that can have significant economic impacts on upstream projects. Resource constraints, such as measurement tools, laboratory capacity, and financial resources, are other factors that make planning for data acquisition and management a necessity along the upstream value chain. Considering these limitations, and despite the high diversity of upstream data, it is only possible to obtain some data. Therefore, it is necessary to prepare a portfolio of various data for different projects and to obtain the necessary data based on the priorities of each project.

A. Successful global experience in data management in the upstream industry

An article in the SPE Reservoir Evaluation & Engineering titled "Information value in the oil and gas industry in the past, present and future", while explaining the value of information and its role in improving decision-making, has collected information such as information value, data value, three-dimensional seismic value, in-well graph value, and other similar topics published and presented in SPE journals and conferences over the years (Bratvold et al., 2009). Accordingly, although the number of papers presented at conferences is greater than the number published in journals, in general, the cumulative number of articles on the value and importance of data in SPE databases has generally increased over the past ten years. This trend indicates the production of knowledge, the importance of the subject, and the increasing attention of experts and managers to this management field.

On the other hand, the work conducted on the value of information and data management is not limited to the SPE articles mentioned, because this field encompasses managerial, decision-making, and executive dimensions, rather than being solely research-focused. As a result, it can be assumed that many such works are being done by managers and specialists of large oil companies, but most of their information and details are not published due to their novelty and importance. In the following, some global findings in the field of information value and data management will be introduced and analyzed.

IV. A MODEL FOR THE QUANTIFICATION OF DATA VALUE AND DATA MANAGEMENT

In a project titled "Quantitative Data Value and Data Management" conducted by a consulting firm called Noah Consulting LLC for Hess Corporation, a recurring method was presented for quantifying the importance and value of data for upstream oil and gas companies, as well as for the quantitative evaluation of various methods of upstream data management (both good and poor). Noah Co. has published a report on the results of this project on its website and has announced that it is excused from publishing the actual figures due to a disagreement with the employer (Hess).

In this report, data is introduced as an "asset" of companies, which due to the many benefits for the companies, requires a numerical value as its importance and value. Its application as a tool for technical and economic feasibility, justification for investing in data acquisition, decision-making about the financial support or lack of support, business cooperation in carrying out a data-related project, and better data utilization compared to other competitors are among the goals and benefits of this numerical value. This report presents a working model that can be replicated for different data, citing the difficulty of attributing a quantitative valid value to the importance of the data. Then, it compares different methods of data management based on the increase or decrease of data value. In this model, the data is analyzed from three perspectives: cost, value, and risk. A numerical value is calculated for each one, and the set of these values is considered as the base state and net value of the data. According to this model, a good data management method increases the value of the data above its net value in the base state, while a poor data management method reduces the value of the data compared to the base state (Haines and Wiseman, 2013).

A. Data cost

Data costs include all costs related to the data that enters the company and is used in decisions. These costs include:

1. The cost of data acquisition, which may arise directly from field sampling (such as charting, core, seismology, etc.) or the result of purchasing data from a data vendor company.
2. The cost of use and application applied to the company, as a result of any processing, changes, conversions, integration, and validation of the data, before using it in decisions. This includes the time spent by experts and the software used in this process.
3. Replacement costs, which may be incurred in the form of sampling or repurchase due to various reasons, such as data loss, loss, intermediate failure of data maintenance, and termination of copyright for data use or interface software.

4. The cost of maintenance, which, like other assets, requires time, effort, money, and resources. This includes activities such as storage, maintenance, uploading, format changes, classification, updating, and support.
5. The cost of decision-making, which is part of the company's total costs, is the result of decisions made based on available data. If such data were unavailable,, these costs would not have arisen for the company. For example, drilling a new well in a reservoir or performing a seismological operation in a field that costs the company are all decisions based on an existing data set, and the ultimate goal is to increase the company's revenue.

Each of the above costs was modeled by Noah Co., and the approximate values for each of them have been presented in the base state row in Table 1. Also, the effect of data management on these costs was investigated in this modeling. The amounts of each cost in the good and poor data management modes have been shown in Table 1 below. The cost of initial data acquisition in all three cases is estimated at $ 1 million, and the total cost, value, and risk of the data are calculated based on this amount. According to the table, the total cost of data in the base state is equal to $ 10 million, and the cost of good and poor data management methods have been estimated at $ 8.8 and $ 15.3 million, respectively (Haines and Wiseman, 2013).

Table 1. Data Cost

Cost	Cost to acquire	Cost to use & leverage	Cost of replace	Cost of maintain	Cost of decisions
Base Case	1000000$	2000000$	800000$	3000000$	3200000$
Good DM	1000000$	600000$	400000$	4000000$	2000000$
Poor DM	1000000$	4000000$	2300000$	2000000$	6000000$

B. Data value

There are many components involved in attributing a numerical value to data:

1. Data time value refers to the changes in data value throughout a project or the life of a reservoir. In most cases, data is used almost immediately after acquisition, which is of great value at that time. Although the value of a particular data usually decreases over time, it may increase again at some point in the future. An approximate diagram illustrating the time value of data has been presented in Fig. 1. Re-interest in a particular field for other projects such as gas storage, inability to obtain new data from the field, and re-need for data at the time of the emergence of new technologies for development are among the reasons for the increase in data value in the future.
2. The functional value of data, which is the result of increasing the efficiency of individuals, is derived from the availability of appropriate data at the right time for the expert forces and the decision-makers within the company and the organization. Their access to data when needed reduces the waste of time searching for it, and its use increases people's performance and efficiency.
3. Data integration value leads to greater usability. The value of data increases when it is integrated with other related data. The information obtained from the integration of the core data of a well with its corresponding in-well diagrams will have a higher value than the sum of the individual values of that data alone. This is due to the creation of synergy and integration. Seismological data integrated with well data allows a more accurate interpretation of the reservoir and finally, it makes better decisions about the field.
4. The decision value of data is, in fact, the value of decisions in the company made based on the use of data. The decision value of data is a large part of the value of data. In the oil and gas industry, it comes from factors like increasing operational productivity, increasing in-place reserves under company management, or increasing company revenue through proper portfolio management. For example, the decision to explore new reserves in a field is made based on data derived from that field. If new reserves

are proven, a part of the value of those reserves can be attributed to the data that led to this decision to conduct exploration operations.

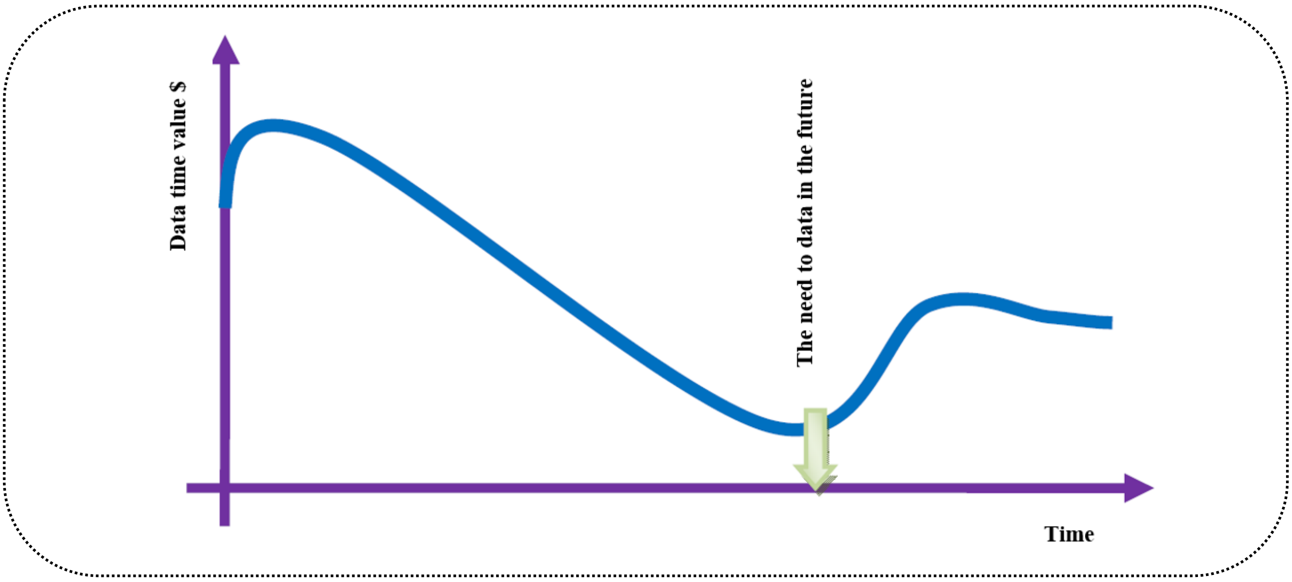

Fig. 1. Data time value

According to the modeling of data value provided by Noah Co., as mentioned earlier, a good data management approach increases the amount of each of these data value components compared to the basic state of data management. In contrast, poor data management methods reduce the value of each component. The numerical values of this modeling have been given in Table 2. According to this table, the total value of data in the basic state is estimated at $ 19 million, and in the states of good and poor data management methods have been estimated at $ 59 and $ 8 million, respectively. This shows the importance of proper data management in creating added value in a company (Haines and Wiseman, 2013).

Table 2. Data Value

Value	Time value	Performance value-improved productivity	Integration value-relevance and applicability	Decision value data usage
Base Case	2000000$	2000000$	4000000$	11000000$
Good DM	4500000$	4500000$	12000000$	38000000$
Poor DM	1000000$	1000000$	2000000$	4000000$$

C. Data risk

Unlike the cost and value mentioned in the previous section, data risk is an indirect component in determining the value and importance of data. In other words, data risk refers to the cost incurred from not using the data or appropriate data at different times. Several components can be considered for data risk, the most important of which are:

1. The legal risk of not using the appropriate data, which refers to the laws and regulations required by the companies operating in the upstream field in any country, region, or province, to observe the activities of exploration, drilling, and production of hydrocarbons. The use of appropriate data and the provision of transparent information on the work done have always been a part of the legal requirements for work in this area and have increased over time.

This is especially true for private companies and contractors, who must provide clear information on their performance at certain times to the government; otherwise, they will be subjected to audits and penalties, which can be considered legal risks and costs associated with not using or providing appropriate data. For example, in Iran, after the complete launch of the upstream information system by the National Oil Company and the obligation of other subsidiaries to enter their data into this system, not providing the requested data can cause such costs for the National Oil Company.

2. The safety and environmental risk of not using the appropriate data is another factor that can impose significant costs on upstream companies. Despite the low probability of dangerous accidents, the impact and cost of such accidents in the upstream industries can be very high. Data plays an important role in preventing such incidents. For example, if drilling near the reservoir is not controlled, the well will face the risk of eruption in the case of a problem in the pressure data, and there is a reservoir rock composition, which will cause high damages and costs.
3. The risk of wrong decision-making is based on not using the correct data, which is, in fact, the same case but the opposite point of producing added value through decision-making using the appropriate data which leads to high costs for upstream companies. This risk is associated with the potential costs related to decisions made in a company with poor data management practices. Part of this cost is spent on reducing side effects or rework.

An example of this issue is digging a dry well due to the absence or incorrect use of data from adjacent wells or latticework at inadequate depth due to misinterpretation of the gamma graph. The data risk values, according to the modeling provided by Noah Co., obtained from the sum of the above three components, have been shown in Table 3.

Table 3. Data Risk

Value	Regulatory risk-data usage	HSE risk-data usage	Decision risk-data usage
Base Case	1000000$	5000000$	4000000$
Good DM	500000$	1000000$	3000000$
Poor DM	2000000$	16000000$	12000000$

The total risk of not using the right data in the basic data management mode is $ 10 million and in the good and weak data management modes is $ 4.5 and $ 30 million, respectively. These values show how the potential cost of risk compensation is reduced in a good data management approach relative to the base state, as proper data management decreases the possibility of rejecting legal deadlines and reporting incorrect data, etc. If the sum of the total legal penalties and possible safety and environmental costs of a company is taken into account, a significant value will be reached, which is very economical to reduce by half (Haines and Wiseman, 2013).

By modeling the good and weak basic data management methods, which show the cost, value, and risk in the three cases mentioned above, based on the values of the above tables, it can be found that a good data management method has reduced the cost and risk of data compared to the base state of data management method and has significantly increased its value. On the other hand, a poor data management method provides higher cost and risk with less added value compared to the base state.

V. INSTITUTE OF ENERGISTICS (FORMERLY POSK)

One of the active departments in the field of data management and knowledge in the energy industry, especially in the upstream oil and gas field, is the Institute of Energistics. Before 2007, this institute was known as Posk. One of the objectives of this institute is to create an impartial reference to facilitate the exchange of exploration and production information, integrate upstream processes, and strengthen the sharing of technical information among oil companies, their internal sectors, servicing and contracting companies, governments, and other actors in this industry through standardization of data transfer protocols and reporting in the upstream oil industry (Karimi, 2012). The standardizations provided by Energistics, according to the official website of this institute until the end of 2014, include the following:

1. Wits-Amal standards
2. Proud-Amal standards
3. Rescue-Amal standards
4. Data management standards and industrial services assets
5. Intercommunication standards in web services Regulatory rules
6. Standards for the use of chemicals
7. Geological standards

These standards use XML markup language to define data types and IT protocols (such as SOAP and S/HTTP) in data transmission. Over time, various versions of the above standards have been provided by Energistics. Fig. 2 shows a presentation of the main data flows in the upstream data acquisition process, highlighting the status of each of the Wits-Amal, Proud-Amal, and Rescue-Amal standards.

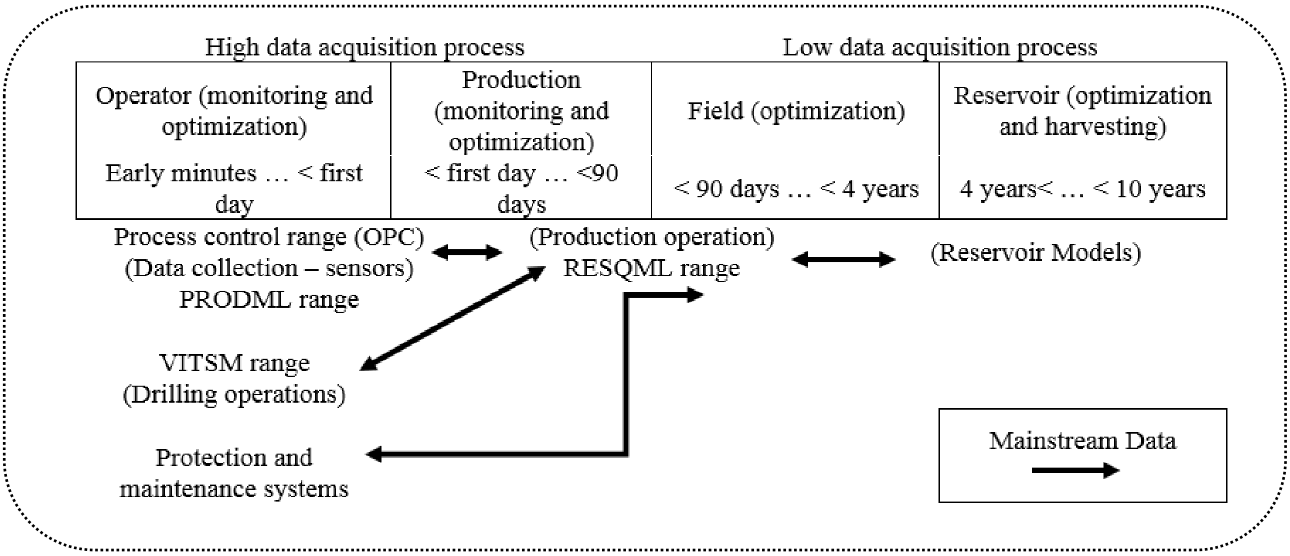

Fig. 2. Positioning Energistics standards in the upstream data acquisition process

VI. SUPPLY CHAIN

Supply chain management is a growing concept in the present technical literature (Jones, 1989; Jones and Riley, 1985; Ellram and Cooper, 1990). The supply chain has many definitions, and is defined depending on the studies. For example, in the paper presented by Jones and Riley, supply chain management is defined as an integrated approach to trading, planning, and controlling the flow of materials from suppliers to the end consumer (Jones and Riley, 1985). In another study, supply chain management refers to a network of companies that interact with each other to deliver a product or service to the end customer, linking raw material flows to final delivery (Jones, 1989).

The action of supply chain management is defined as a set of activities performed by an organization to promote its effective management (Li et al., 2005). Supply chain management is a multidimensional concept that is considered to be more comprehensive. Hence, this concept includes downward and upward domains of the supply chain, and if the best-selected experiences are implemented, a set of supply chain activities is recognized as an effective supply chain operation (Zhou and Benton, 2007).

In general, the supply chain in the oil industry can be shown in Fig. 3.

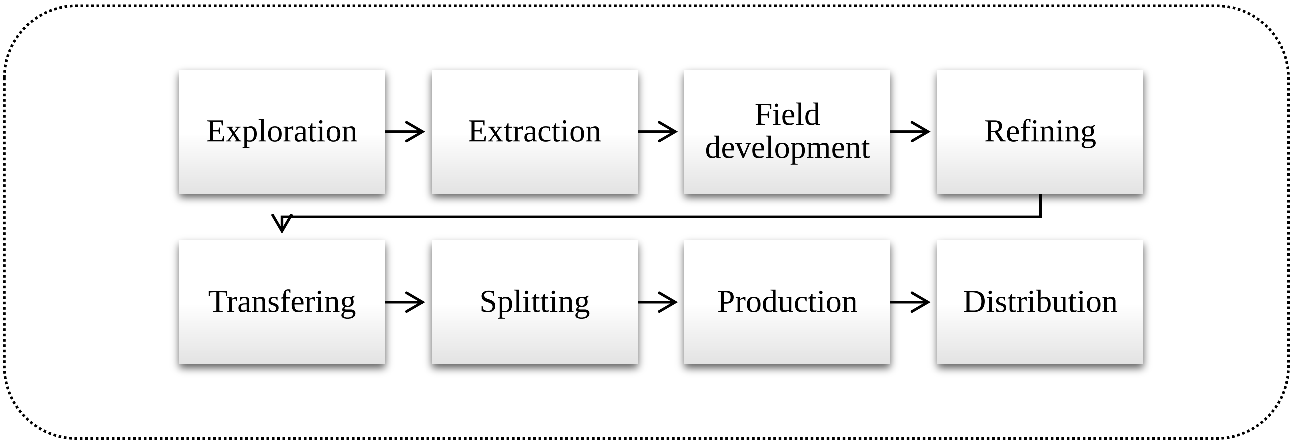

Fig. 3. General oil industry supply chain

Oilfield development operations and the refining process are among the most important, longest, and most costly supply chain processes in the oil industry. The refining process is also a part of the oil industry's value chain and is doubly important in these chains. The elastic state of the supply chain is defined as the firm's ability to stay alert, adapt, and quickly respond to changes caused by supply chain disruptions (Ambulkar et al., 2015).

A. The role of data mining in supply chain management

Over the years, supply chain management and information technology management have attracted a great deal of attention from activists and researchers. With the evolution of information technology, companies are becoming more integrated. Therefore, integrating effective supply chain practices with effective information sharing is essential for improving supply chain performance. Supply chain activities focus on material movement (Hwang and Rau, 2006). Many managers mistakenly focus their information sharing on hardware and software alone, regardless of the decision-making process (Davenport, 1994).

What makes the difference in performance is the application approach of information. The results showed that IT investment alone is not enough. A company can achieve effective performance only when management teams emphasize technology investment and select appropriate information to share (Schroeder and Flynn, 2001).

In general, information content can be categorized as supplier information, manufacturer information, customer information, distribution information, and retail information (Handfield and Nichols, 1999; Chopra and Meindl, 2001). In addition to advanced manufacturing technologies, many applications of supply chain management information technology have emerged in recent years and have been widely used in supply chain management (Boyer et al., 1997; Boyer and Pagell, 2000).

Effective information sharing between different parts of the supply chain further enhances supply chain initiatives. These initiatives include managed inventory, ongoing replenishment schedules, joint forecasting and re-supply, and effective customer response (Chen and Chen, 1997; Lummus and Vokurka, 1999; Lee and Whang, 2000). Business environmental dynamics are defined as unpredictable changes in products, technology, and market demand for products (Miller and Friesen, 1983; Dess and Davis, 1984). It has been suggested that supply chains with different environmental dynamics (e.g., variable demand versus sustainable demand) should use different supply chain practices (Fisher, 1997).

Fig. 4 clearly shows the relationship between supply chain operations, information sharing, and supply chain dynamics (Zhou and Benton, 2007).

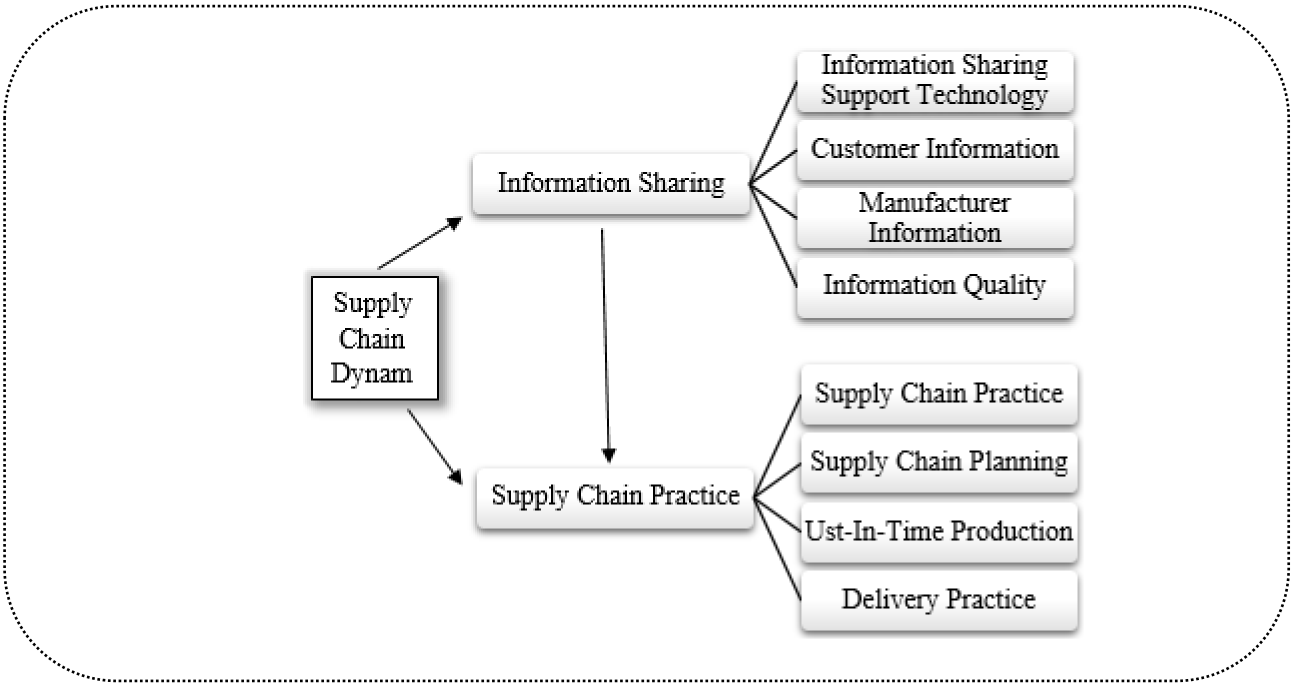

Fig. 4. Relationship between supply chain operation, information sharing, and supply chain dynamics

B. Value Chain

The rapid evolution of supply chain management as a sub-order in operations management provides strong evidence that companies no longer compete except in the value chain (Christopher, 1998). A series of numerous studies, along with the remarkable success of companies such as Wal-Mart, Amazon, Toyota, and Zara, clearly demonstrates that a company's ability to design and manage its value chain has become the cornerstone of simultaneous management (Kapuscinski et al., 2004; Holweg and Pil, 2001).

A value chain is a set of activities that a company works in a particular industry to provide a valuable product to the market. This concept, acquired through business management, was first described by Michael Porter in 1985 as a competitive advantage (creating and maintaining superior performance) (Porter and Kramer, 1985). The concept of value chains as a decision support tool was also added to the competitive strategy (Porter, 1979).

Oil production is a capital-intensive process and technology that can range in complexity from small offshore projects to decades-long projects. In addition, many exploration and production activities are long-term investments, which can take a decade or more from the initial prospect of producing wells. As a result, this industry is planning and operating with long lead times and price risk exposure. Oil is also a key input in a variety of products, including plastics and chemical fertilizers. For example, laundry detergent, eyeglasses, rubber, garbage bags, and ammonia all contain oil. In general, any step that causes a change in the monetary value of oil is introduced as a value chain in the oil industry, making refineries the most effective member of the value chain in the oil industry.

Drilling is a cutting process that uses a drill bit to separate a cross hole in a solid. A drilling rig is usually a rotating cutting tool, often with several points. The tool is pressed onto the workpiece and rotates rapidly, from hundreds to thousands of revolutions per minute. This action puts the cutting edge on the workpiece and separates the chips from the hole.

The amount of data collected during the drilling of wells and gravity wells has increased significantly. A well-organized operations data model can easily facilitate analysis by using the following:

1. Simple Query Language (SQL)
2. Summary of output reports
3. Sophisticated data analysis tools

This allows operation engineers to perform any type of structured query for the following:

1. Types of analyzes
2. Performance modeling
3. Research
4. A set of statistical information for corporate or government reporting

Typically, commercial software systems provide data analysis tools in which queries and analytics can be shared across the network. These systems store the query with the data so that it can be reused at any time.

C. Data analysis and management in drilling

Many types of exploration and production (E&P) data easily present themselves as communication rows and columns. However, some important data types in the oil industry have particular performance concerns because of their size. Good graphing, seismic mapping, and continuous sensor readings are examples of data types that can produce vast amounts of data. Large data items cannot be stored efficiently using the row-column abstraction of relational databases. This data is effectively stored in bubble data types, either within the database or in operating system files outside the database. An E&P project management system should integrate and represent these specialized data types seamlessly with more traditional communication data in the user's integrated representations.

Oil industry data in the drilling section, considering the sensitivity and riskiness of this section, is presented as daily drilling reports (DDR) for complete control over the drilling process, as well as the progress of work and forecasts required for the future days.

Project data management tools should separate end users from the complexity of directly working with the database while performing shared data management tasks. Data inputs-outputs and routines support a wide variety of data exchange formats. These tools should manage units of measurement and unit conversion when needed. They must also convert surface positions between different mapping systems. Other domain-specific capabilities are provided when specific data types are introduced (for example, calculating well path from guidance survey information). Data browsing tools, queries, and editing tools should fill in the gap left by horizontal queries and browsing tools, which provide industry-specific representations for key data types, such as logs, production charts, and seismic displays. These tools should allow for the updating and editing of project data and should implement standard business rules and data integrity.

VII. THE MOST IMPORTANT JOINT MEMBER IN THE SUPPLY CHAIN AND VALUE CHAIN: REFINING

The refining process is part of the downstream processes of the oil industry. Refineries convert crude oil into petroleum products for use as fuels for transportation, heating, asphalting, electricity generation, and as raw materials for chemical production. Refining converts crude oil into its various components, which are then selectively converted to new products. Oil refineries are complex and expensive. All refineries have three main stages:

1. Separation

Modern separation includes piping crude oil through hot furnaces. The resulting liquids are discharged to distillation units. All refineries have atmospheric treatment units, while more sophisticated refineries may have vacuum distillation units.

2. Conversion

After distillation, lower-value distillation parts can be processed into lighter, value-added products such as gasoline. Here, parts of the distillation units are converted into sources (intermediate components) that eventually become the final products.

3. Addition

The final stages occur during the final treatment. To make gasoline, refinery technicians carefully combine the various currents available from the processing units. Octane grade, vapor pressure rating, and other special considerations determine gasoline composition.

A. Examination of data in refineries

Refinery datasets include fuel, electricity, and steam purchased for use in refineries. The refinery capacity report does not contain shell storage capacity data. The review of refining data is of great importance and is necessary for any data collection project. For example, to manage supply and demand, as well as the production or import of the required products, each country must first have complete information about the consumption of products and consumer demand, and then decide whether products must be imported or exported according to its production capacity. To meet the demands of their customers, countries, governments, and companies must also make predictions and take measures to develop their oil industry, increase the output of products in this industry, and collect and analyze the available information to make the right decisions in all areas.

VIII. DIVISION OF DIFFERENT COMPANIES IN THE OIL INSUDTRY

There are several companies in the oil industry from which this classification of value chain concepts originates, even before the formal development of value chain management (Inkpen and Moffett, 2011).

1. Integrated Oil and Gas Company

A company that performs upstream operations well. Some of these well-known companies in this field are Aramco of Saudi Arabia, ExxonMobil, Royal Dutch Shell, and Chevron Texaco.

2. Independent oil and gas company

A company that has either upstream or downstream operations, but not both. Some of the well-known companies in this field are Anadarko Petroleum, Sunoco, Philips 66, ConocoPhillips, and Murphy Oil.

3. Oil Services Company

A company that supplies products or services to the oil and gas industry, usually a combination of labor, equipment, or other support services. Some of the famous companies in this field are Schlumberger, Halliburton, Saipem, and Baker Hughes.

4. Manufacturer of oil equipment

A company that specializes in the sale and distribution of equipment to the oil and gas industry. Some of the well-known companies in this field are Siemens, Schneider, and ABB Group.

5. Security

Many large security companies are involved in securing the industry.

There are other companies in the industry that do not fit the classifications above, as software companies provide essential IT services for easy implementation in the oil field.

IX. DATA-BASED ECONOMICS

The data economy is a global phenomenon and a digital ecosystem composed of different participants, such as data providers and users. This term refers to the ability of organizations and individuals to use data as assets. Data is used for strategic decisions, operational efficiency improvement, sustainable growth, efficiency, welfare, and innovation. The value and impact of data increase with situational, textual, historical, and temporal factors. Integrating, refining, and sharing data increases its value and impact. Effective use of data can lead to company growth, improved quality of life, and the creation of efficient communities. However, the effective use of data can be hindered by irregular data forms, data models, and problems with efficient information exchange (Flyverbom and Madsen, 2015).

The data economy will expand in the future with the development of the Internet of Things. Forecasts show that there will be 24 billion Internet-connected devices by 2020. That is, on average, four devices are connected to the Internet per person. Each of these devices generates valuable data from individuals. Hence, the volume of data and the diversity of production data will be much greater. By adding this data to today's big data, even environmental advertising can be optimized. Suppose that when you are walking in front of a billboard in the subway, the goods you need are introduced on that billboard. The development of the Internet of Things and its entry into the field of big data can be an important turning point.

Monetization through data analysis is a new field in data economics. Data analysis was developed by focusing on two needs:

A) The number of users is increasing, and the volume of data they produce is rising rapidly. How can this amount of data be stored?
B) Users have different interests and tastes and live in different parts of the world. How can advertising be targeted? How can we introduce a product that the user is interested in?

These two needs raised a new issue in this area. The technology initially used for the data set made it possible to optimally store large volumes of data. The analytical tools created on the topic of big data also made it possible to analyze the data and present immediate results.

X. MANAGEMENT KNOWLEDGE

Knowledge refers to the differentiation of observers from objects, which, in the context of experience, results in a coherent set of coordinated actions (Zeleny, 1987). Conceptual knowledge goes beyond information; information means that data is meaningful. Information becomes knowledge when a person reads, understands, interprets, and applies information about a particular function of work. Knowledge is revealed when experienced people apply practical lessons over time (Lee and Yang, 2000). In an article entitled “From Data to Wisdom”, Ackoff presents a hierarchy of data, information, knowledge, and wisdom, the generalities of which are agreed upon in scientific sources. Accordingly, data constitute the first level of data and knowledge management and are the basis for producing information and knowledge required in decisions and the formation of wisdom (Ackoff, 1989). Information, which is relevant and purposeful, has a specific meaning and occupies the next level, while knowledge is needed to convert data into information (Drucker, 1998).

Management is the process of useful and effective use of all material and human resources under the accepted value system of a society, according to general principles such as planning, organizing, using resources and facilities, guiding and controlling, and monitoring based on predetermined goals (Terry and Franklin, 1972).

Some essential principles in the management of any organization are as follows (Jeyaraj and Zadeh, 2020; Kao et al., 2020):

1. Each employee must have special responsibilities (division of responsibilities);

2. Explicitly explain all the rules and regulations of the organization to employees;
3. Ensure the presence of common interests for the organization among employees of each group;
4. Complete assurance of the correct progress of the members of the organization in one direction and for one goal;
5. The project team should receive instructions from only one person and execute it, and each group should have a separate chairman;
6. Inform the managers of the sub-groups of the company about relevant decisions;
7. Create job security for employees;
8. Encourage employees to be creative and motivated at work;
9. Strengthen the morale of the project team and strive for coordination and cohesion of the group;
10. Ensure the appropriate rewards for members of the organization.

XI. CONCLUSION

The data management department is one of the most important parts of any organization. Input data for this section must be evaluated by data analysis tools. After analysis by tools, these raw and meaningless data become practical concepts in management, which are called information. It is clear that a large volume of data does not mean good data quality, so the data must be collected at the right time and in the examined context and then evaluated. At this stage, valuable information obtained from data analysis is used to make decisions at the senior levels of the organization.

Large oil and gas companies, with full knowledge of this issue, have considered the development of policies, systems, and methods of the identification and control of the data needed to obtain information in a timely and economical manner. They relate the data to its place of application and analyze the type of application as their work priorities, institutionalizing and defining planners to implement these decisions. Accordingly, it is necessary to take a comprehensive and integrated view of this issue to prevent the reduction of system efficiency, thereby avoiding losses or diminished profits.

The main idea behind supply chain management is that companies and firms place themselves in the supply chain by exchanging information about market fluctuations and production capabilities. Integrating effective supply chain operations with effective information sharing is critical to improving supply chain performance. Only when management teams emphasize technology investment and select the right information to share can a company achieve effective performance. Operational and managerial data directly impact the members of the supply chain and value chain, thus influencing the direct management of these two chains. Proper analysis of all operational and managerial data is essential to improve supply chain and value chain performance and is a basic requirement of the oil industry. It is concluded that, in addition to the needs of the upstream and downstream parts of the oil industry for data collection and analysis, the collected data must meet these conditions: it must be collected at the right time, the appropriate field for data collection must be selected, enough volume of data must be collected, data collection must occur at a suitable velocity, and finally, the data must be updated. In this way, the company can provide the necessary grounds to obtain reliable results.

REFERENCES

Ackoff, R. L. (1989). Fromdata to wistom, Journal of Applied Systems Analysis, 16, 3-9.

Ambulkar, S., Blackhurst, J., & Grawe, S, (2015), Firm's resilience to supply chain disruptions: Scale development and empirical examination, Journal of operations management, 33, 111-122.

Azin, R., Nasiri, A., & Jodeyri Entezari, A. (2008). Underground Gas Storage in a Partially Depleted Gas Reservoir, Oil & Gas Science and Technology, 63(6), 691-703.

Bhattarai, B. P., Paudyal, S., Luo, Y., Mohanpurkar, M., Cheung, K., Tonkoski, R., ... & Zhang, X. (2019). Big data analytics in smart grids: state-of-the-art, challenges, opportunities, and future directions. IET Smart Grid, 2(2), 141-154.

Blanchard, D. (2010). Supply chain management best practices, John Wiley & Sons.

Boyer, K. K., Leong, G. K., Ward, P. T., Krajewski, L. J. (1997). Unlocking the potential of advanced manufacturing technologies, Journal of operations management, 15(4), 331-347.

Boyer, K. K., & Pagell. M. (2000). Measurement issues in empirical research: improving measures of operations strategy and advanced manufacturing technology, Journal of Operations Management, 18(3), 361-374.

Bratvold, R. B., Bickel, J. E., & Lohne, H. P. (2009). Value of Information in the Oil and Gas Industry: past, present, and Future, Society of Petroleum Engineers, 12(4), https://doi.org/10.2118/110378-PA.

Chen, S., & Chen, R. (1997), Manufacturer-supplier relationship in a JIT environment, Production and Inventory Management Journal, 38(1), 58.

Chopra, S., & Meindl, P. (2001). Supply chain management: Strategy, Planning, and operation, Upper Saddle River, NY; Prentice Hall.Christopher, M. (1998). Logistics and supply chain management. Edinburgh Gate. Harlow, UK: Pearson Education Limited.

Davenport, T. H. (1994). Saving IT's soul: Human-centered information management, Harvard business review, 72(2), 119-31.

Dess, G. G., & Davis, P. S. (1984). Generic strategies as determinants of strategic group membership and organizational performance, Academy of Management journal, 27(3), 467-488.

Drucker, P. F. (1998). Harvard Business Review on Knowledge Management, Harvard Business Press.

Ellram, L. M, & Cooper, M. C. (1990) Supply chain management, partnership, and the shipper-third party relationship, The International Journal of Logistics Management, 1(2), 1-10.

Fisher, M. L. (1997). What is the right supply chain for your product? Harvard business review, 75, 105-117.

Flyverbom, M., & Madsen, A. K. (2015). Sorting data out-unpacking big data value chains and algorithmic knowledge production, in Die Gesellschaft der Daten, Transcript, 140-161.

Frické, M. H. (2018). Data-Information-Knowledge-Wisdom (DIKW) Pyramid, Framework, Continuum, Springer International Publishing AG, part of Springer Nature 2018L. A. Schintler, C.L. McNeely (eds.), Encyclopedia of Big Data, https://doi.org/10.1007/978-3-319-32001-4_331-1.

Geekiyanage, S. C., Tunkiel, A., & Sui, D. (2021). Drilling data quality improvement and information extraction with case studies. journal of petroleum Exploration and Production, 11, 819-837.

Haines .P & Wiseman, M. (2013). Management Data and Data of Value Quantitative, presented at the 15th annual international conference on petroleum data integration, data & information management.

Handfield, R., & Nichols Jr, E. (1999). Introduction to. Supply Chain Management, Prentice Hall, Englewood Cliffs, NJ.

Holweg, M., & Pil, F. K. (2001). Successful build-to-order strategies start with the customer, MIT Sloan Management Review, 43(1), 74.

Hwang, M. H., & Rau, H. (2006). Development of strategies for shortening supply chain and demand chain, Human Systems Management, 25(4), 255-263.

Inkpen, A. C., Moffett, M. H. (2011). The global oil & gas industry: management, strategy & finance, PennWell Books.

Jayagopal, V., & Basser, K. K. (2022). Data management and big data analytics: Data management in digital economy. In Research Anthology on Big Data Analytics, Architectures, and Applications, 1614-1633. IGI Global.

Jeyaraj, A., & Zadeh, A. H. (2020). Evolution of information systems research: Insights from topic modeling, Information & Management, 57(4), 103207.

Jones, C. (1989). Supply chain management–the key issues, BPICS control, 15(6), 23-26.

Jones, T. C., & Riley, D. W. (1985). Using inventory for competitive advantage through supply chain management, International Journal of Physical Distribution & Materials Management.

Kao, P. J., Pai, P., & Tsai, H. T. (2020). Looking at both sides of relationship dynamics in virtual communities: A social exchange theoretical lens, Information & Management, 57(4), 103210.

Kapuscinski, R., Zhang, R. Q., Carbonneau, P., Moore, R., & Reeves, B. (2004). Inventory decisions in Dell's supply chain, Interfaces, 34(3), 191-205.

Karimi, M. (2012). Timely data management in the upstream area of the oil industry, Exploration and Production Monthly, 89, 16-19.

Kozlenkova, I. V., Hult, G. T. M., Lund, D. J., Mena, J. A., & Kekec, P. (2015). The role of marketing channels in supply chain management, Journal of Retailing, 91(4), 586-609.

Lee, H. L, & Whang, S. (2000). Information sharing in a supply chain, International Journal of Manufacturing Technology and Management, 1(1), 79-93.

Lee, C. C, & Yang, J. (2000), Knowledge value chain, Journal of management development.

Li, S., Rao, S. S., Ragu-Nathan, T., & Ragu-Nathan, B. (2005). Development and validation of a measurement instrument for studying supply chain management practices, Journal of operations management, 23(6), 618-641.

Lummus, R. R., & Vokurka, R. J. (1999). Managing the demand chain through managing the information flow: capturing "moments of information", Production and Inventory Management Journal, 40(1), 16.

Marins, M. A., Barros, B. D., Santos, I. H., Barrionuevo, D. C., Vargas, R. E., Prego, T. D. M., & Netto, S. L. (2021). Fault detection and classification in oil wells and production/service lines using random forest. Journal of Petroleum Science and Engineering, 197, 107879.

Miller, D., & Friesen, P. H. (1983). Strategy-making and environment: the third link, Strategic management journal, 4(3), 221-235.

Montenegro, A., Dobrota, M., Todorovic, M., Slavinski, T., & Obradovic, V. (2021). Impact of construction project managers' emotional intelligence on project success. Sustainability, 13(19), 10804.

Nagurney, A. (2006). Supply chain network economics: dynamics of prices flows and profits. Edward Elgar Publishing.

Nguyen, T., Gosine, R. G., & Warrian, P. (2020). A systematic review of big data analytics for oil and gas industry 4.0. IEEE access, 8, 61183-61201.Oliver, R., & Webber, M. (1982). Supply-chain management: Logistics catches up with strategy. Outlook; reprinted in Christopher, MG (1992), Logistics, the strategic issue, London: Chapman and Hal, 63-75.

Porter, M. E. (1979). How Competitive Forces Shape Strategy, Harvard Business Review, 57(2), 137-145.

Porter, M. E., & Kramer, M. R. (1985). Advantage, Creating and Sustaining Superior Performance, Simons.

Rowley, J. (2007). The wisdom hierachy: represntations of the DIKW hierarchy, Jurnal of Informatio Science, 33(2), https://doi.org/10.1177/0165551506070706.

Salehi, A., Ahmadi, A. A., & Sharif Moghadam, H. (2019). Knowledge Management, Payame Noor University.

Schroeder, R. G., & Flynn, B. B. (2001). High performance manufacturing: Just another fad .High Performance Manufacturing-Global Perspectives, John Wiley & Sons, Inc., New York.

Sees, R. H. (2013). Guide to supply chain management: How getting it right boosts corporate performance (the economist) by David jacoby, Transportation Journal, 52(4), 522-524.

Shafiei, N., Pakizeh, M., & Razavi Sarasia, A. (2013). Study and study of natural gas storage status in underground reservoirs of Iran and other countries, Iranian Journal of Chemical Engineering, 12(67), 46-56.

Tan, V., Aziz, K. A., & Razavi, S. H. (2022, December). Data Analytics for Effective Project Management in the Oil and Gas Industry. In International Conference on Technology and Innovation Management (ICTIM 2022), 233-242. Atlantis Press.

Terry, G. R., & Franklin, S. G. (1972). Principles of management. RD Irwin Homewood, IL.

Zeleny, M. (1987). Management support systems: towards integrated knowledge management, Human systems management, 7(1), 59-70.

Zhou, H., & Benton, Jr. W. (2007). Supply chain practice and information sharing, Journal of Operations management, 25(6), 1348-1365.