Blockchain Technology and Supply Chain: An Application Review

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Abstract

The market of oil and gas encompasses long-term, high-risk projects, which leads companies to search for solutions that can bring more reliability and efficiency to their processes. Blockchain technology has emerged in the financial market but has expanded to other fields where one of the most promising markets for its use is in the supply chains of materials and services. By means of bibliographical research, it has been possible to identify the main applications of this technology, as well as to evaluate its current stage of deployment and its main aspects. It was possible to investigate replacement automation, modelling of logistics and supply operations, digitalization, costing, payment systems and smart contracts, which from a pool of several hundred publications, demonstrated to be the most important ones about the usage of blockchain in the supply chain.

Keywords

Blockchain, Oil and gas, Supply chain.

1. Introduction

The expression "supply chain" was created in the 1990s in China along with the already then flourishing industrialization of the country. This early, the branch of logistics was stimulated by the so-called Enterprise Resource Planning (ERP), which focused on the integration of processes and data from corporations (GOMES, 2018).

A supply chain can be defined as the processes that are related to the activities of transportation of resources and inputs, from the supplier to the final consumer, thus linking the companies from the initial source to their destination. Hence, such a network links both sides of a series of processes and activities which produce value in the form of products and services, ultimately placed in the hands of the end consumer. The supply chain management is based on a model that has the function of meeting the synergies through the integration of business processes, whose main purpose is to serve

the final consumer most efficiently and effectively, that is, with services or products noticed by the final customer and purchased for as cheap as possible.

The supply chain encompasses different areas, such as purchasing, demand forecasting, production, distribution, stocks, and transportation, interacting in strategic, tactical, and operational perspectives. This management involves the coordination of information, material, and financial flows among several companies (BALDIN *et al*, 2003).

Globalization within supply chains imposes the creation of multifaceted regulations and the immense diversification of cultural and human behavior, making it difficult to process information and deal with risks in unsafe networks (IVANOV *et al.*, 2018). Growing problems such as transaction inefficiency, transaction fraud, and inaccurate supply chain operations result in lower-reliability incursions, bringing about a demand for better information sharing and more reliable verifying means (SABERI *et al.*, 2019).

In this context, open blockchain technology looks promising as a distributed ledger technology that incorporates a decentralized network, where each transaction is immutably recorded, verified, and stored as encrypted information (FRAGA-LAMAS and FERNÁNDEZ-CARAMÉS, 2018). Rejeb *et al.* (2019) mention that this potential makes this technology open to the new era based on IoT (Internet of Things), which can provide greater transparency, traceability, and security throughout the supply chain network.

In addition, blockchain is an increasingly expanding technology in a variety of fields, such as in the supply chain, having a growth rate of 87% per year and projecting a market of \$3,314.6 million by 2023 (KAMILARIS *et al.*, 2019). Blockchain technology grew in popularity with the emergence of cryptocurrency and Bitcoin aiming at being incorporated into financial applications (NAKAMOTO, 2008). However, the characteristics of authenticity, which is characteristic of this technology, have served as a scaffold for broader use in other non-correlated areas, in the vanguard of which Blockchain is present (KOUHIZADEH and SARKIS, 2018). Blockchain is essentially different from most of the most widespread programming software architectures as it consists of four distinct features: decentralization, visibility, auditability, and smart deployment (STEINER and BAKER, 2015).

The implementation of blockchain along the supply chains has been growing increasingly day after day in cooperation with the Internet of Things (IoT) and with machines providing automated operational data, therefore increasing efficiency (PETER et al., 2019). This comprises smart devices (for example. sensors, radio frequency identification tags etc.) mutually interconnected, to enable data mining and data access through a communication network (DORSEMAINE et al., 2015). Additionally, considering the distributed, resilient, and immutable composition of blockchain technology, all branches of a global supply chain (for example procurement, manufacturing, distribution, service) are potentially convenient for the use of this technology (AICH *et al.*, 2019).

On the other hand, some researchers also regard the vulnerability of blockchain in terms of security, accuracy, and compatibility (LIN and LIAO, 2017; KHAN and SALAH, 2018; REYNA *et al.*, 2018). Besides, there is a limited number of studies in the literature which examine the relationship between blockchain technology and the aspects of organizational sustainability (KOUHIZADEH and SARKIS, 2018; SABERI *et al.*, 2019). In this context, sustainability and Supply chain concerns cover many different aspects (e.g., environmental, economic, technological, organizational) and each of them needs to be inquired about whether they have intersections with the boundaries of open technology use cases.

From this point on, a better-detailed analysis can be made regarding the effectiveness, performance, and capabilities achieved by employing blockchain technology via supply chain networks (SABERI *et al.*, 2019). In addition, the predominant characteristics of the company, industry, product creation, service, and market can impact the adoption of blockchain technology for the supply chain sector (KOUHIZADEH and SARKIS, 2018).

In the literature, scientific studies on blockchain and its affinity with sustainable practices seem to be too incipient to give rise to ideas and theories about future use cases of this technology for the sake of the supply chain. In practical terms, global research organisations and consulting companies continuously conduct use case studies on how blockchain technology can be effectively used for purchasing networks. According to a recent report, almost 90% of

blockchain-based supply chain initiatives are at risk of being inefficiently adopted due to the lack of viable use cases (GARTNER, 2018a).

On the other hand, these companies also address the revolutionary role of blockchain technology, specifically indicating its transformational impacts on supply chains (GARTNER, 2019b). Still, blockchain seems to be a growing problem every day, which should still cause restlessness to supply chains in many respects.

Blockchain is expected to contribute significantly to the supply chain, bringing significant advancements in terms of accountability, transparency, and traceability, while maintaining the symmetry of possession of information throughout all the partners.

Thus, the main objective of the paper is to review the literature available in academia and identify the main lines of research focusing on applications of Blockchain technology

2. Literature Review

The definition of blockchain is a List of Links, or Block Technology, with each one containing several transactions. This technology provides a decentralized and unchanged data storage system that serves a network of users. It can act as a shared ledger that records all transactions (ZHONG *et al.*, 2017) and is used to create features.

Each transaction can be easily consulted, providing greater transparency and trust among all stakeholders. Since the original creator, or creators, is or are anonymous, the real purpose behind the creation of Blockchain is undisputedly unknown. However, it has proven to be a more than adequate solution to many issues, taking into consideration that various clients (individuals or organisations) have a copy of it, which in turn needs to be consolidated and validated. According to Kshetri (2017a), Blockchain is presented as a technology that can provide a strong and robust cyber security solution and a high level of privacy protection. Its proponents argue that such technology is safe by design. In a blockchain-based model, there is no need to store information with third parties.

For many authors, part of the fascinating character of Blockchain derives from the fact that personal forum data must be viewed and accessed only with the permission of the real owner, and such information cannot be stored. The proof of identity (KSHETRI, 2017b) - as the process is called - is stored in a cryptographic design, which makes it impossible or extremely difficult to break (KHAN, 2017).

The security features of many of the important systems in many industries depend on the so-called "security through obscurity" approach (KSHETRI, 2017c) in security engineering. The studies in this line aim to keep the security mechanisms and the implementation of the system in complete anonymity. However, a major disadvantage of this method is that the entire system can collapse when one finds out the security mechanism. A fact that is already known after several studies is that such practice becomes practically fruitless when using the disruptive technology of Blockchain.

3. Methods

The research was accomplished across the scientific literature aiming to target the identification of the "state of the art" of the applications of Blockchain technology focused on the supply chain. Thereafter, a detailed analysis of the chosen articles was made. Finally, the results were presented through summaries of the contents of the articles, tables, and graphics.

The review of the literature concerning this topic was realized employing the research technique called bibliometric, which, according to Costa (2010) and the SCOPUS database, was used as the source.

4. Data Collection

During the research, there were found 9,068 and 5,698 occurrences for the term "Blockchain" and "Block Chain", respectively. In the search for the term "Block chain", it could be verified the existence of 5,698 citations, with The United States and China being the countries which have published the most (26.0% and 23.9% publications,

respectively). In comparison, there is a sharp difference relative to other countries, for example, Brazil (1.3% of publications).

For the term "Blockchain Logistics", 148 results were found, having been mentioned by 21 publications. For the term "Blockchain Supply", 98 results were found, having been quoted by 49 publications. Within these 148 publications of Blockchain Logistics, the texts focused on demonstrating the industries' ability to understand how the open technology had been evolving in logistics, predominantly focused on maritime cargo transportation, as well as cabotage shipping and maritime support of vessels to FPSO construction.

With regards to the term "Blockchain supply", 98 results were found. They covered mostly automation processes and general factory shutdowns, disclosing interest from academia in analyzing resupply processes, strategic purchasing lines using automated purchasing portals, and security lines based on IoT and RFID (Radio-Frequency Identification) for industries with continuous processes of warehouses. In these papers, it could be observed how technology starts to interact with the reliability network throughout the supply chain processes.

In Table 1, it is possible to notice that it still lacks research and publications about blockchain applied in the supply chain if compared with research in supplies and logistics properly referenced.

Term	Results
"Logistics"	360.823
"Supply Chain"	77.949
"Blockchain"	4.863
"Blockchain Logistics"	147
"Supply Chain Blockchain"	291

Table 1: Results from the research of the terms in the literature.

Among the searches conducted, it is possible to see the scarcity of scientific publications involving blockchain (or Block Chain), specifically in supply area involving open technology projects, indicating the presence of a gap in the studies.

5. Results and Discussion

The crucial aspect of this bibliographic research was to identify the main blockchain applications in supply chain area, regarding the use of management tools that this technology provides. Thus, Table 2 summarizes these findings, which are subsequently discussed.

Tools and Methods	Authors
Resupplying Automation	Mengelkamp <i>et al.</i> , 2018; Bohme <i>et al.</i> , 2015; Sikorski <i>et al.</i> , 2017; Iansiti and Lakhani, 2017; Xu <i>et al.</i> , 2016; Lemieux, 2016; Francisco and Swanson, 2018; Sun <i>et al.</i> , 2016; Ølnes <i>et al.</i> , 2017; Li and Wang, 2017; Xie <i>et al.</i> , 2018; Corbet <i>et al.</i> , 2018; Christidis and Devetsikiotis, 2016; Mendling <i>et al.</i> , 2018; Kshetri, 2017a; Kshetri, 2017b; Henchion, 2017; Underwood, 2016.
Logistics Operation Modelling	Babbitt and Dietz, 2014; Christidis and Devetsikiotis, 2016; Burcher, Decker and Wattenhofer, 2018; Harer and Fill, 2019; Rosu <i>et al.</i> , 2018; Frank, 2018; Kim and Laskowski, 2016; Lankhorst, 2017; Luu <i>et al.</i> , 2017; Sape, 2019; Van Eck <i>et al.</i> ,

	2010); Farah <i>et al.</i> , 2018; Jaipuria and Mahapatra, 2014; Yang <i>et al.</i> , 2018; Mao <i>et al.</i> , 2018; Al-Saqaf and Seidler, 2017; Wang <i>et al.</i> , 2018; Kshetri, 2017c.
Supply Operation Modelling	Farah <i>et al.</i> , 2018; Mahapatra <i>et al.</i> , 2012; Yang <i>et al.</i> , 2018; Mao <i>et al.</i> , 2018; Al-Saqaf and Seidler, 2017; Wang <i>et al.</i> , 2018; Kshetri, 2017a; Christidis and Devetsikiotis, 2016.
Performance Metrics	Nields and Moriz, 2017; Groenfeldt, 2017; Hannam, 2017; Higgins <i>et al.</i> , 2018; Swafford <i>et al.</i> , 2008.
Digitization of Operations	Treiblmaier, 2018; Douglas and Kandaswamy, 2018; Lyons-white and Knight, 2018; Bridges and Fowler, 2017; Popper and Lohr, 2017; Childerhouse <i>et al.</i> , 2003; Tykhonov <i>et al.</i> , 2017.
Operations Costing	Zhang and Wen, 2017; Zhang <i>et al.</i> , 2016; Cheah and Fry, 2015; Raisaro <i>et al.</i> , 2019.
Payment System	Nanayakkara et al., 2019; Behera et al., 2015; Moon, Abd-karin et al., 2014; Abeysekara et al., 2014; Khaqqi et al., 2018.
Smart Contracts	Zhang <i>et.al.</i> 2019; Casey and Vigna, 2017; Correia, 2018; Frias, 2018; Gomes, 2019; Ioannis <i>et al.</i> , 2017; Miles, 2018; Orcutt, 2018; Wright and De Filippi, 2015.

5.1 Resupplying Automation

Errors in warehouses are common - such as errors in stock data, missed shipments and duplicate payments - and are usually impossible to detect in real-time. Even when a problem is discovered after the fact, it is challenging and expensive to identify its causative agent or to correct it by tracing the sequence of activities recorded in the available documents and accounting entries (HOLBL *et al.*, 2018). Although ERP systems track all types of information flow, it can be hard to assess which record entries (accounts receivable, payments, credits from returns, and so on) correspond to a certain inventory transaction. This is especially true for companies doing thousands of transactions every day across a large network of supply chain partners and products (SABERI; KOUHIZADEH and SARKIS, 2019).

To make matters worse, the activities of a supply chain are usually extremely complex - much more than the exposure displays. For example, orders, shipments, and payments may not synchronize perfectly either because an order may be split into multiple shipments and corresponding invoices, or multiple orders may be combined into a single shipment. A common approach to optimize the execution of the supply chain is to evaluate the transactions through auditing (SHAREEF, 2020). Auditing is necessary to ensure compliance with contracts but is of little help in improving decision-making to address operational deficiencies. Consider the problem a food company faces when its products reach the end of their shelf life in a retail shop. An audit or stock inspection in a shop may reveal the number of expired items, but it does not explain the causes. It could happen due to failure halfway in the supply chain, such as inefficient inventory management, placement of products in the stores, weak or sporadic demand, and inadequate shelf rotation (failure to place older products in front of newer ones). A record of such activities can help reduce expired food items. Another way to improve supply chain operations would be to label stock goods with RFID (Radio Frequency Identification) tags or electronic product codes that conform with the GS1 standards (globally accepted rules for handling supply chain data), integrating a company's ERP systems with those of its suppliers to build a complete record of transactions. This would eliminate errors and refine traceability (XU *et al.*, 2016). However, the experience of the companies we have studied hitherto has shown that integrating ERP systems is expensive and time-consuming.

Smart sensors can be connected to the blockchain technology in inventory management, along with near-expired products to an e-house module which monitors and creates data directly in the purchasing platform (IANSITI and LAKHANI, 2017). Bocek *et al.* (2017) describe in an article a practical use case of incorporation of IoT and blockchain sensor devices into the delivery chain of an electrical module for the construction line of an FPSO. This pilot test aimed to ensure data immutability and public accessibility of temperature data recording in the transport of this module between locations to ensure quality control and regulatory compliance with the European Union legislation "GDP" (Good Distribution Practice of Products). The sensor devices should monitor the temperature of each line of near-expired items during shipment to ensure regulation, thereafter, transmitting information to the purchasing towers or ERP with open blockchain technology, where a smart contract assesses the details about the product. Finally, the

contractor can scan the code and check which equipment may have suffered alteration and address these non-conformities.

Blockchain improves tracking and brings transparency to the logistics and tracking process for products that are critical to the operation, especially when one has an established itemization of near-expired products, which leads to an improved delivery cycle, monitoring, and control. In a traditional purchasing system, if the supply chain is wide and bears a broad distribution network, as we can see within projects of oil and gas, the chances of discrepancy are higher, and blockchain technology can be very useful in this case to overcome such dissimilarities (LU *et al.*, 2017). Product tracking devices for items with constant replenishment needs, such as RFID, can be integrated into the blockchain.

These devices can provide input data to the blockchain, and this information cannot be deleted. Blockchain facilitates the traceability of a new purchase of products within a dynamic inventory (TIAN, 2016) and subsequently improves operational efficiency, especially for outbound logistics. Integration of blockchain: IoT, QR Code, and mobile apps can be used by the warehouse purchasing system to verify new orders or even the warranty of the item during its transportation between repositories.

5.2 Logistics operation modelling

Blockchain has also been identified as a management solution for IoT devices and networks. Blockchain stores immutable information about data transactions and communication between IoT nodes, maintains historical data about mobility, tracks data from source to destination, and ensures data integrity and authentication.

Based on the model of Blockchain, it is possible to create an autonomous network management system for IoT networks and devices (HUH, CHO and KIM, 2017.).

Within the supply chain, there are numerous ways to demonstrate the IoT process, and a Blockchain-based chain is a decentralized database line with continuous and permanent growth of records (ledgers). Carvalho *et al.* (2019) mentions that this base is distributed by nature, meaning there is no central computer managing and maintaining data for the entire chain. In addition, blockchain provides scalability for access to IoT data and device networks, including key management (SAMANIEGO *et al.*; 2020).

5.3 Supply operation modelling

A blockchain-based supply chain is promising and reliable in terms of traceability and authentication, eliminating even the need for intermediary auditors. As per Kshetri (2017c), one of the first possible functionalities is to apply blockchain to track all actions in the supply chain, such as who is performing the actions, at what time, and where the location of each action is happening.

Each partner in the supply chain can track products, shipments, deliveries, and progress. They can also easily measure the performance of each supply chain activity and monitor the quality of products during transportation (CHEN *et al.*, 2018). Therefore, a blockchain-based supply chain reduces workload and ensures traceability, while increasing efficiency, reducing costs, and ensuring more confidence that products are genuine and of high quality (KSHETRI, 2017c).

Obviously, the applications and usability of blockchain in supply chains have been consistently increasing with the support of IoT, along with the assistance of machines providing operational data automatically. It is more efficient to track and control objects from their sources by using IoT (FRANCISCO and SWANSON, 2018). However, blockchain is still incipient in many aspects and does not transform critical activities in the supply chain. Therefore, there is a large gap between the potential of blockchain and its application in the supply chain. In addition, many companies still have little knowledge about blockchain, and there are not many ready-to-use applications of blockchain in the supply chain domain yet (PETERSON, YOUNG and GORDON, 2016). Many companies and researchers are trying to embrace the trend of the deployment of blockchain by basing themselves on their business goals, but the effects of blockchain on the supply chain have not yet been systematically assessed. Several open questions about blockchain remain in the research field. For researchers, it is interesting to investigate the direction of blockchain in business and technology innovation. For the companies, it is important both to know when blockchain will pay off positive returns after overcoming constraints and who will benefit most from it, especially in supply chain management.

5.4 Performance Metrics

In the era of the fourth industrial revolution, recent technologies such as IoT, 3D printing, and blockchain have changed the way people do business (RAJPUT and SINGH, 2019). Companies want to increase financial benefits not only by

selling products and services, but also by adopting modern tools, techniques, and technologies to improve the performance of business models (LU *et al.*, 2017). Now, the competition seems to be among business models (VISWANADHAM, 2018). Supply chain management systems provide information and metrics to industries to perform their planning actions (HUANG *et al.*, 2017; WANG *et al.*, 2019; YADAV *et al.*, 2018).

This sharing of information among stakeholders is essential to deploy certain activities according to the fluctuation of the market (DOBROVNIK *et al.*, 2018; NAKASUMI, 2017). Information is distorted from downstream to upstream of a supply chain due to the addition of new information at every stage (RAJPUT and SINGH, 2019). Sharing of incomplete information can result in the problem of divergences between the data about demand and inventory, as known as the bullwhip effect (HUANG *et al.*, 2017). Discrepancies in information between stakeholders of the supply chain management system led to planning breakdown and reduce the efficiency and effectiveness of the chain itself (SINGH *et al.*, 2017. Adopting blockchain can solve this problem.

With the use of blockchain, which is a decentralized and distributed database, it is possible to maintain a continuously growing list of records or project metrics. The oil and gas industry uses a shared data infrastructure that refreshes in real time with the use of blockchain and can process and settle transactions in minutes using computer algorithms. There is no need for third-party verification. However, blockchain can improve transactions in many domains of an organization, including CS through the secure exchange of data in a distributed manner (LO *et al.*, 2018; WANG *et al.*, 2018). The adoption of blockchain technology can increase the trust of a customer. This will help increase reliability, and hence the performance of the entire supply chain by increasing its efficiency and transparency.

5.5 Digitalization of Supplies

Organisations, primarily within the oil and gas market, have encountered institutional pressures to change their business strategic perspectives (ZHANG *et al.*, 2015; MIKALEF *et al.*, 2013). These pressures require institutions and individuals to rethink and redesign their operational activities and supply chain functions. Green information systems - a traditional category of digitization - refer to hardware, systems, open technologies such as Blockchain, and other infrastructures that are designed to improve information flow and management from an environmental sustainability perspective (WANG and SARKIS *et al.*, 2013). Evidence of this prominence of the concept of "greening" and its influence on organizational strategic planning was present in many research publications and investigations in IMDS (International Material Data System) (WANG *et al.*, 2018).

In this context, digital disruption is already affecting supply chains and urging new manufacturing strategies (SIAVAS et. Al., 2014). This promotes a shift from traditional production planning and control to distributed manufacturing (DM) and from large-scale to micro-scale, with multiple local manufactures (MACCARTHY *et al.*, 2016). Moreover, the decentralization of manufacturing with 3D printing applications (KAPETANIOU *et al.*, 2018), also known as additive manufacturing, is enabling the potential for mass customization (MACCARTHY *et al.*, 2016). Thus, traditional supply chains will eventually face the challenge of having to upgrade to digital supply chains to support new production and transportation systems, as well as their customer experience and relationship based on, among other things, real-time information exchange.

5.6 Supply Costing

Within the oil and gas supply chain market and with the new technologies and moments of oscillations in the economy, it is increasingly clear that organisations should be aware of how to invest and how to reduce costs to boost their numbers (WERNKE et al., 2014). It is through a good knowledge of administration, finance, and basic concepts of cost control that the company will be able to obtain good financial results.

According to Wernke (2014), the expenditures of an institution are financial sacrifices, in which the company uses its resources or takes on debts in exchange for obtaining goods or services. Expenses are divided into disbursements, investments, losses, expenses, waste, costs, and scrap.

Disbursement represents the payment of goods or services whose data is recorded at the time of the event, regardless of its occurrence or discharge. Investments are expenditures applied in the expectation of obtaining benefits in the future; in other words, it is when the company focuses on receiving a future return in the form of manufactured products (WERNKE, 2014).

With Blockchain, digital associations are formed and protected. Blockchain is on the brink of fundamentally modifying the way humans and machines engage in fiscal activity in an everlasting way. While humans have used prescribed organisations to reduce uncertainty in trade since the beginning of time, blockchain is evolving within this outdated model into something far more interesting, the autonomous distribution of costs.

Blockchain innovation has recently emerged from the shadows of the deep web into the bright lights of corporate financial Information Technology. Because of its beneficial security conditions, this technology provides many simple cases of use and incorporation within enterprise resource planning (ERP).

ERP software connected with supply chain costing supervises and optimizes business processes. It is a kind of central database processing hub which enables an organization to perform BackOffice work more easily and continuously with the help of integrated applications. ERP structure within the financial universe utilizes a database administration structure. In addition, Blockchain also uses a real-time scalable database that encourages checking ideas, steps, and forms for tax and asset adjustments.

For example, if a promotional staff utilize a certain software to create accounts and the accounting department needs similar accounts to supervise their businesses, this network becomes necessary to exchange information among each other.

Be that as it may, this system regularly creates shortcuts between companies. The reason may be the lack of trust between two groups or the absence of similarity.

Since each institution follows an unmistakable arrangement of business benchmarks, procedures, and protocols, it will be much less demanding for everyone to comprehend the innovation Blockchain brings about (KASTELEIN, 2017). Moreover, Blockchain does not remain on the ground of ROI (Return Over Investment") but rather relies on key principles such as opposition, cyber-attacks, and other malware dangers. ERP is a fundamental piece of an organization as it handles accounts, invoices, purchase orders, and payments. Blockchain integration with ERP frameworks will empower genuine interoperability information for different businesses and banks, services such as online payments, trade finance companies, and contract administration offices.

As blockchain continues to develop and discover appropriation in areas other than digital money, ERP suppliers are attempting to integrate the accounting innovation as a traceable and immutable record for everything from delivery shows and supply chains to hardware maintenance and dispute resolution systems (HAN and SHIN, 2016).

In theory, Blockchain and ERP have quite more in common, as ERP is bound to have a single data variant, and Blockchain also hopes to make a single data table that is shared by millions of customers on the web. Because of this apparent similarity, theories that Blockchain may replace ERP sooner or later have started to emerge.

In any case, theorists can disregard the central contrast between ERP and Blockchain. Not overall, as there should be an occurrence of ERP in Blockchain, the data is decentralized and can be accessed by several ventures in the meantime. Within Blockchain, the flow of information targets directly each of its members, but none of them alone can control or modify the information without agreement. This specific feature of distributed ledger innovation gives robustness to the system by embedding ERP into Blockchain. Such coordination can be vital in building trust between different organizations.

Blockchain should be seen as a constant application that can make data sharing between various parties more consistent, providing a protected communication channel. The integration can provide companies access to updated information from corporate systems and share management, capacity of such information.

Stakeholders having an interest in Blockchain can give specific access to their data for costing or financial record information. The record of each transaction present in a Blockchain is genuine, requiring preferences (KASTELEIN, 2017).

The idea that Blockchain will replace traditional ERP is something we have to become accustomed to, and then focus our concentration only on integrating these systems, which is particularly feasible and promotes high levels of

confidence. One should not lose sight of the main problem and should consider the big and small improvements reached due to the integration between ERP and Blockchain (KASTELEIN, 2017).

Unlike routine ERP updates, the marches for change advance toward making new arrangements of finance activity, bringing together the real and virtual universes - and this suggests better offering methodologies, new relationships with clients, assistants, and suppliers, and new legitimate structures (KASTELEIN, 2017).

"In recent years, ERP software providers gradually became aware that blockchain will significantly affect their businesses, sectors, and items soon." "Before the end of 2017, there will be blockchain running within ERP structures in many networks inside of the companies," says Han and Shin (2017) of the American Blockchain Council. "Inventory networking and coordination will be more generally used initially. "By 2020, the usage of an enabled Blockchain system within ERP will be widespread and commonplace" (KASTELEIN, 2017).

5.7 Payment System in Supply Chain

The oil and gas industry produces some of the most complex and largest equipment for extraction, such as FPSOs, modules, tanks, and complex buildings. This complex construction demands the joint approach of specialists in all areas, product suppliers, components, and sub-elements throughout different supply chains (ASHWORTH and PERERA, 2018). Typically, this industry has dynamic, extensive, and network-structured supply chains with many internal and external suppliers (BEHERA *et al.*, 2015). It is a project-based chain, which has inherent uncertainty risks due to the complexity of its system. The most adverse impacts are inefficiencies, compliance issues, long payment cycles, and inefficacy in finance and payments. In addition to those factors, the long payment settlement periods stipulated in contractual arrangements, payment delays, and partial or unpaid payments, quite recurring in the oil & gas industry, also contribute to this insecurity. Due to these payment setbacks, the cost of its financing is significantly raised to cover the risk, increasing the total cost of the construction. Therefore, payment and related financial issues are categorized as one of the most crucial issues in this industry.

Another related aspect is that there is a financing culture, and the standard periods for instalment payments are much higher than in other industries. Generally, in construction projects, payments are made progressively based on the cost of the work deployed over a given period or the completion of an agreed milestone. The terms of contracts stipulate the payment settlement procedure. Generally, there are fixed deadlines for preparing, checking, and certifying the invoice and concluding the payment. Ashworth and Perera, (2018) mentioned that 1.6% of revenue is lost due to delayed payments in this industry. This long cycle for instalment settlement usually takes a few months (KHAQQI *et al.*, 2018). The researchers identified that this model of financing their debts hinders the downstream knots in the supply chain, such as subcontractors, subcontractors, and suppliers. Moreover, partial payments and payment defaults are usually common in the construction industry, jeopardizing, even more, the situation for upstream members (ABEYSEKERA, 2015).

5.8 Smart Contracts

In the light of governance, Blockchain can contribute to the transparency of information within the oil and gas market to society through the application of information technology, also named e-governance. As all the information transacted within the Blockchain is recorded and cannot be removed, as explained by Swan (2015), the oil & gas market can use it as a tool to facilitate its application and perhaps change the interrelation between government and companies, cooperating in developing the supply chain with other organisations (OLNES; UBACHT; JANSSEN, 2017).

The term Smart Contracts was introduced by Nicholas Szabo in 1994, who defined an SC as a computerized transaction protocol that executes the terms of a contract. A traditional way of conceptualizing a contract, as cited by Swan (2015), would be an agreement between two or more parties to or not to do something in exchange for something else. Each party must rely on each other to fulfil their side of the obligation. In Brazilian literature, on the other hand, according to, a contract is the agreement between two or more people to establish, regulate, or terminate a legal bond. The mechanisms for governance trust, in the competence and formal contract, provide unique facilitating conditions for Inter organizational learning. In this way, Smart Contracts have the same type of agreement to or not to comply, but they eliminate the need for a type of verifier between the two stakeholders. Also, according to Swan (2015), this happens because a Smart Contract is defined and run - or forced - by the code automatically, without cunning or manipulation. That is to say, the operation of the Smart Contract follows the logic if X, then Y contained in the code

by which the contract will be governed. Thus, this type of contract becomes self-running to the extent that the observance of the condition triggers the result.

The Smart Contract is created within a digital application platform. The most widely known is the decentralized digital platform created by Buterin (2014) and Wood (2014) called Ethereum. According to its creators, Ethereum is analogous to an international computer approaching a virtual machine - named Ethereum Virtual Machine (EVM) - with a complete computing language, also known as Turing language, capable of solving many problems using universal scripting computational language known as solidity, yet subject to future development and updates. Additionally, according to Buterin (2014), Ethereum is used to build any mathematically descriptive attributes through the mechanism of the contract. This language allows developers from all parts of the world to write their own contracts, distributing them on Ethereum's decentralized network.

6. Conclusion

The research could identify the most noticeable applications of Blockchain technology employed in the oil and gas industry, the focus of this work, from an extensive literature investigation in academia. Eight principal applications could be identified (Resupplying Automation, modelling of logistics and supply operations, digitalization, costing, payment system, and smart contracts), and it was possible to analyze the current stage of their employment and the main aspects of their applicability.

This work demonstrated that many of the applications studied are still in their initial stages of use, with great possibility for expansion.

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Biography

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