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Review

Identifying Blockchain Technology Maturity's Levels in the Oil and Gas Industry

Mohammadali Hassani [a], Ghasemali Bazaeeand[b*], Ashraf Shahmansouri[c]

[a]Ph.D. Student in Information Technology Management, Islamic Azad University, South Tehran Branch, Iran, Email: hassani_mohammadali@yahoo.com

[b]Assistant Professor, Islamic Azad University, Central Tehran Branch, Iran, Email: ghasemalibazaee@gmail.com

[c] Assistant Professor, Islamic Azad University, South Tehran Branch, Iran, Email: shahmansoury92@gmail.com

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ABSTRACT

Currently, blockchain in the oil and gas industry is still experimental, and many people do not acknowledge this technology. Blockchain technology can bring many opportunities, such as reducing transaction business costs and increasing transparency to the oil and gas industry. However, because blockchain is an emerging technology, organizations need to investigate the maturity stages to increase this technology's readiness and adoption. The Capability Maturity Model (CMM) is one of the standard models in information technology. This model is widely adopted as a public maturity model in business processes, industry, and IS/IT organizations. The blockchain technology maturity model is classified into five levels of emerging, identified, defined, operational, and mature to identify the applications of this technology toward flourishing and providing the ultimate solution to most of the organization's problems. Therefore, this qualitative research has been designed to identify maturity levels to provide a conceptual model of maturity levels of blockchain technology in the grounded theory. First, the initial factors were extracted by reviewing the research background; then, semi-structured interviews with 12 blockchain technology experts collected the data. The meaning and characteristics of the blockchain maturity model challenges are presented in three stages of coding: identification, classification, and finally, creating the research model. The reliability of the interviews was confirmed by the reliability methods of Test–Retest and intra-subject agreement. The results of data analysis indicate that experts at the emerging level to primary educating and technology monitoring, at the identified level, to recognize the applications of this technology and regulation, at the defined level, to develop a roadmap, proof of concept (POC), and feasibility, at the operational level, the stakeholder resistance, and at the matured level, the entry new members, the consortium, and increasing attention to maturity requirements, is a spotlight with more frequency than other indicators and elements.

1. Introduction

According to a report presented by Markets and Markets in 2019, the Compound Annual growth Rate (CAGR) for the natural oil and gas automation market is expected to be at least 6.7% in the coming five years, which means that the industry reliability and safety are critical (Singhi, 2019). Currently, the automation of the supply chain of the oil and gas industry is necessary because it helps manufacturers integrate information and provides them with robust control and safety solutions to respond appropriately to global demand (Trilivas, 2019).

[*] Corresponding author

DNV-GL designed the dynamic model In 2017 this model purports that the decrease in production costs by 2024 is mainly due to automation and digitalization in this industry. Nearly 50% of senior oil and gas experts agree that greater use of automation and digitalization will increase profitability in the oil sector over the next five years. It is important to note that oil and gas organizations with digitalization will be able to produce safer products, increasing the demand in the oil and gas industry (Trilivas, 2019). The Gartner Institute's 2019 report also showed that oil and gas companies are eager to embrace new digital technologies and change their operating practices. This hype cycle provides the Chief Information Officer (CIO) with in-depth assessments of 37 technology capabilities with the highest potential for improving oil and gas business performance. As shown in Figure 1, the blockchain is still in the "Innovation Trigger" section (i.e., still being reviewed by the primary trustees). The report also shows that the innovation curve is widening. Gartner believes that the area will mature in five to ten years. For example, the blockchain of VAKT Trading Company covers more than 90% of North Sea oil. The relatively small number of key players is the main reason for the relative maturity (Singhi, 2019).

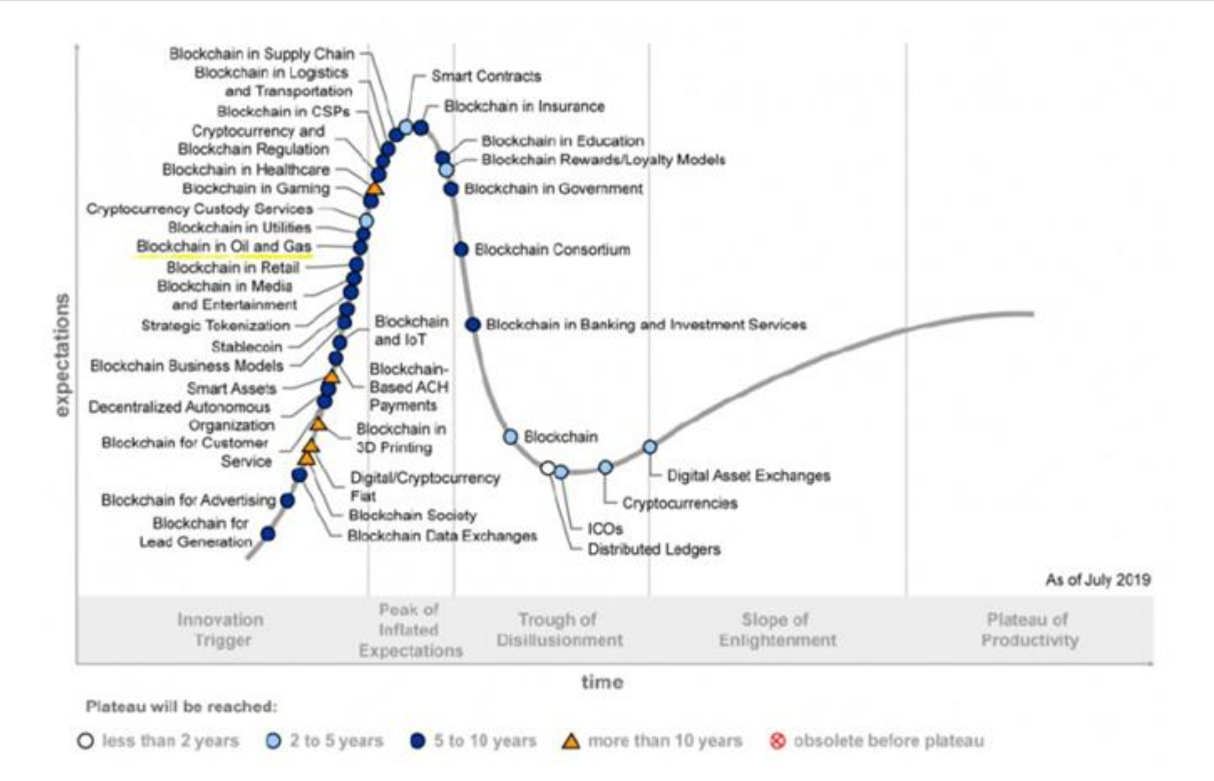

Figure 1. The hybpe cycle for blockchain businesses (Gartner, 2019).

"In essence, the blockchain is a common, programmable, secure, and therefore reliable cryptocurrency," stated by the Founder and Executive Chairman of the World Economic Forum in his book, The Fourth Industrial Revolution (Industry 4,0). In a survey conducted on 800 Chief Executive Officers (CEOs), 58% believed that up to 10% of global Gross Domestic Product (GDP) would be stored using blockchain technology(Infosys.2017). The total blockchain market will reach about 2.3 billion $ by 2021, according to Markets. Blockchains will be in the process of 'growth' and creating the potential for new markets or 'growth' and strengthening existing markets(Infosys.2017).

On the other hand, in the digital revolution era, the need for advanced information and communication technology is felt among the oil and gas industry to support the increasing challenges of de-carbonization, decentralization, digitalization, and security. Blockchain technology has emerged in this area to provide an integrated platform through various applications such as metering, billing, carbon trading, security, supply chain management, and performance-based contracts. The opportunities and impacts of using blockchain-based contracts, including economic, environmental, operational, and social-related benefits, will be demonstrated. Although blockchain technology will lead to far-reaching changes, current applications are still in the early development stages. In the oil and gas industry, key areas of progress need to be assessed to achieve optimal scalability levels, decentralization, and security (Kadry,2020). However, blockchain technology has been developed for more than 10 years and has become a trend in various industries (Lu et al., 2019). With the gradual process of the oil and gas industry towards digitalization and smartening, many oil and gas companies have focused on blockchain activity in the last two years because it can significantly increase management and efficiency and improve data security for the oil gas industry. Europe and Asia currently have the fastest development rate of blockchain applications in the oil and gas industry (Lu et al., 2019). From the authors' point of view, there are still few oil and gas blockchain projects in operation or testing. Nowadays, the understanding of blockchain in the oil and gas industry is not enough. The application is still in the experimental stage, and the investment in this project is not enough. The blockchain can offer the oil and gas industry many opportunities to reduce transaction costs and improve transparency and productivity. However, since we are still in the early stages of its application, there are many challenges, mainly in the technology, regulation, and system transformation.

Blockchain development in the oil and gas industry will move towards Hybrid blockchain architecture, multi-technology combinations, cross-chain, combined consensus mechanisms, and interdisciplinary professionals (Lu et al. 2019). In the meantime, the changes due to the blockchain require preparation, and this readiness can facilitate the adoption and implementation of the blockchain. Without examining the industry's readiness to welcome the blockchain, it cannot be expected that the various areas of activity in the energy industry will receive a reasonable or appropriate response from the implementation of blockchain projects (Ayazi and Nilforoshan, 2020). "The blockchain is still evolving, and we need to address challenges and deliver not only in our industry but also in all related industries, "Rebecca Hoffman, manager of the OOC Oil & Gas Blockchain Consortium, believes the blockchain continues to evolve and mature.And the new associate companies will significantly accelerate our learning and enhance the capabilities of our consortium (Businesswire, 2020). Therefore, for the oil and gas industry to flourish and provide solutions tailored to the problems of organizations in this area using the Capability Maturity Model (CMM), which is one of the standard models in the area of information technology, can be widely beneficial as the general maturity model in business processes, industry, and IS/IT organizations. In fact, the blockchain technology maturity model is classified into five levels of emerging, identified, defined, operational, and matured to identify the applications of this technology. Therefore, from the tactical view, the blockchain maturity model technology helps organizations identify and be aware of the position in which they are, to get acquainted with the set of necessary measures to increase their level of maturity to purposefully and move systematically to the next level.

Table 1. Background and research sources.

Given the above, this research is interoperable. Because many companies, managers, and owners, in many cases (especially in critical periods of the company's life), need to know the level of their company from a particular perspective (e.g., architecture, information management, strategy, innovation, and security). Generally, according to internal and external available resources, blockchain technology in the oil and gas industry is in its infancy. Also, many organizations and companies consider investing in this technology to be high risk. Therefore, this study intends to better understand the theory of Distributed Ledger Technology (DLT)[1] and blockchain technology by examining the three blocks of maturity levels, influential factors, risks, and challenges of blockchain technology experts. Accordingly, the present study seeks to provide a model of blockchain technology maturity in the oil and gas industry.

2. Literature Review

Based on Mendeley Desktop search, the essential library resources in three blocks of maturity levels, affecting factors and risks of the blockchain maturity model, are listed in Table (1).

[1] Distributed Ledger Technology

Authors	Year	Title	Result
Mingaleva et al.	2020	Implementation of Digitization and Blockchain Methods in the Oil and Gas Sector	Blockchain technology is essential if Russian oil and gas companies want to compete in global, national, and local markets.
Kadry	2020	Blockchain Applications in Midstream Oil and Gas Industry	This paper concludes that this technology has significant potential to increase efficiency and maximize the profits required for further industry research.
Abad	2020	Blockchain Applied to the E&P Phase in the Oil & Gas Sector	This paper describes the methods of operating a blockchain-based extraction device in hydrocarbon production, storage, or processing facilities.
Boneti & Leader	2020	Blockchain Ledger for Persisting and Verifying Oil and Gas Events	This article describes how to store data for an oil and gas event along with a blockchain ledger that stores one or more event identifying characteristics.
Uba & Whitfield	2020	Exploring the adoption of blockchain technology in the oil and gas industry supply chain	This study shows that the adoption of blockchain technology increases the efficiency of the supply chain.
Trilivas	2020	the Technology Foresight in the Oil and Gas Industry – an Exploratory Overview of the Energy Field.”	New technologies are used in the oil and gas sector, but various challenges, from cyber threats to the complexity of ICT solutions, hinder their effective adoption and use.
Mumcular	2020	Blockchain meets natural gas: a case study of the University of British Columbia and Xpansiv from an operations research perspective	This study aims to understand the potential benefits of the Xpansiv technology platform that can be created to buy UBC natural gas at the University of Vancouver.
Wang & Su	2020	Integrating blockchain technology into the energy sector-from theory of blockchain to research and application of energy blockchain	The blockchain may provide renewable energy and strengthen our energy sustainability.
Miglani et al.	2020	Blockchain for the Internet of Energy management:	Due to the challenges related to energy management using blockchain technology, such as 51% attack and security of smart contracts (not fully approved by experts), network

Authors	Year	Title	Result
		Review, solutions, and challenges	latency, storage volume, scalability, and sufficient cost of blockchain communication, this technology has not matured enough to be widely accepted.
Ayazi and Nilforoushan	2020	Assessment of the scope of oil and gas companies' activities based on their readiness to accept blockchain technology	In this paper, after assessing the scope of oil and gas companies' activities based on their readiness to accept blockchain technology in oil and gas companies, sales groups are likely to adopt blockchain. Then the design and development of applications in the field of blockchain-based energy services are more inclined to adopt this technology in the area of oil and gas, respectively.
Blanco	2019	Impact of Blockchain in the Oil and Gas Industry	This study shows the main obstacles to adopting blockchain technology and its actual application from upstream to downstream.
Lu et al	2019	Blockchain technology in the oil and gas industry: A review of applications, opportunities, challenges, and risks	Applying the blockchain in the oil and gas industry is expressed in four aspects: trading, management and decision-making, monitoring, and cybersecurity. Its opportunities and challenges have also been explored.
Brilliantova & Thurner	2019	Blockchain and the future of energy	This article provides a comprehensive overview of the application of blockchain in the energy sector. It is powerful and versatile technology in the face of two emerging economies in South Africa and Russia.
Andoni et al.	2019	Blockchain technology in the energy sector: A systematic review of challenges and opportunities	This technology faces many challenges in achieving market penetration, including legal, regulatory, and competitive barriers. These challenges include security breaches, vulnerabilities of various operating systems of this technology.
Morkunas et al.	2019	How blockchain technologies impact business models	Delay from consensus operations, the high processing time to maintain data confidentiality, data security, non-standard blockchain in terms of uniformity of procedures in different protocols, high cost of blockchain implementation, and limitations of regulations and rules the challenge of this technology has been raised.
Anderson & William	2018	Digital Maturity Model Achieving digital maturity to drive growth	DMM can help identify gaps and create critical areas and starting points.
Stratopoulos & Wang	2018	blockchain technology adoption	Introduction of four technology adopters, including innovators, early adopters, secondary majority, and laggards.
van der Voort, & Spenkelink	2018	Blockchain Maturity Model	Doing an IT maturity assessment to give organizations more insight and guidance on how to achieve these concepts.

Authors	Year	Title	Result
Vermeij	2018	Creating an IT risk maturity model for distributed ledger applications	This study discussed the maturity model of information technology risks and distributed ledger technology applications.
KPMG	2017	Blockchain Maturity Model	User access and management, cryptography key management, authorization and security management, data management and segregation, interoperability and integration, scalability, performance, change management, privacy, and security are risks.
Rahmati and Shavalpour	2017	Blockchain technology capabilities in the oil and gas industry	This paper states that blockchain technology as a transformational technology could create great potential in the oil industry. Reducing costs, reducing transaction times, and eliminating fraud risks have also been cited as some of the benefits of this technology.
Le Borne et al.	2017	SWIFT on distributed ledger technologies	Every new technology must meet the requirements at an acceptable level, such as solid governance, data controls, compliance with regulatory requirements, standardization, identity framework, security, and cyber defense, reliability, scalability, and efficiency.
Spenkelink	2017	blockchain: with great power comes great responsibility	The distributed ledger technology is still very immature, and it must be ensured that all IT risks are appropriately addressed.
Wang et al.	2016	A maturity model for blockchain adoption.	The blockchain may provide renewable energy and enhance our energy sustainability.
Becker et al.	2009	Developing Maturity Models for IT Management - A Procedure Model and its Application.	Maturity models are valuable tools for IT managers. These models make it possible to assess the current situation and improve the status of the organization.

3. Blockchain

Blockchain technology became famous as the basis of the Bitcoin network in 2008 and has since been used in several blockchain applications with different architectures. Blockchain technology can be described as a decentralized digital transaction ledger of a peer-to-peer network and a distributed database (Nakamoto, 2008; Prieto et al., 2020). The blockchain database increasingly collects transaction logs and adds them to “nodes”, called blocks. These blocks have a timestamp and are encrypted with the previous blocks to form a “chain” of records (Nakamoto, 2008). Then, copies of transactions are stored on all distributed computers or “nodes” (PwC, 2018).

Therefore, the blockchain system works in this area in a decentralized manner without a central reference. In order to facilitate, verify, execute, and record those transactions, the blockchain uses nodes involved in transaction processing (Xu et al., 2019).

3.1. How the Blockchain Works

Blockchain is a distributed database of transactions, repeated in an identical copy in multiple nodes (kim.2018). According to Figure 2, blockchain performance can be expressed based on the following five steps:

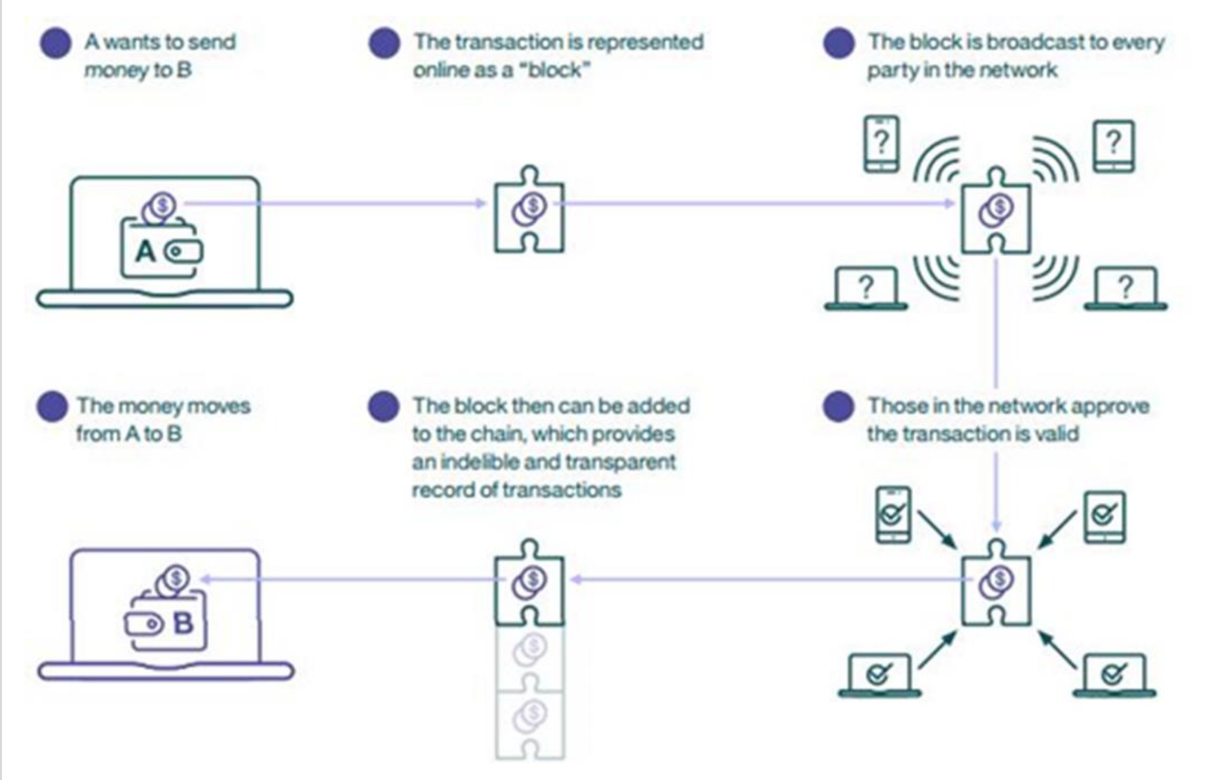

Figure 2. How the blockchain works.

1 Sending financial transactions from A to B.

2 .Creating a transaction request as a "block" in the network.

3 .Approves and also registers the transaction request in the network.

4 .The block joins the chain and records the request transparently and irreversibly.

5 .The last transaction deposits a request to account B.

3.2. Blockchain in the Oil and Gas Industry

As oil and gas resources play a significant role in energy, oil and gas industry technologies have also developed rapidly in recent years, such as intelligent drilling technology, intelligent oil and gas devices, and digital marine platforms. The oil and gas industry is gradually evolving towards the direction of intellectualization, digitalization, and automation. However, its management mode is relatively old and has low efficiency, high cost, long period, and high risk. According to the market division, the oil and gas industry can be divided into upstream, midstream, and downstream. Upstream refers to oil and gas exploration and development, midstream refers to oil and gas transportation, and downstream refers to storage and sales. The value chain of the oil and gas industry is shown in Figure 3 (Lu et al., 2019).

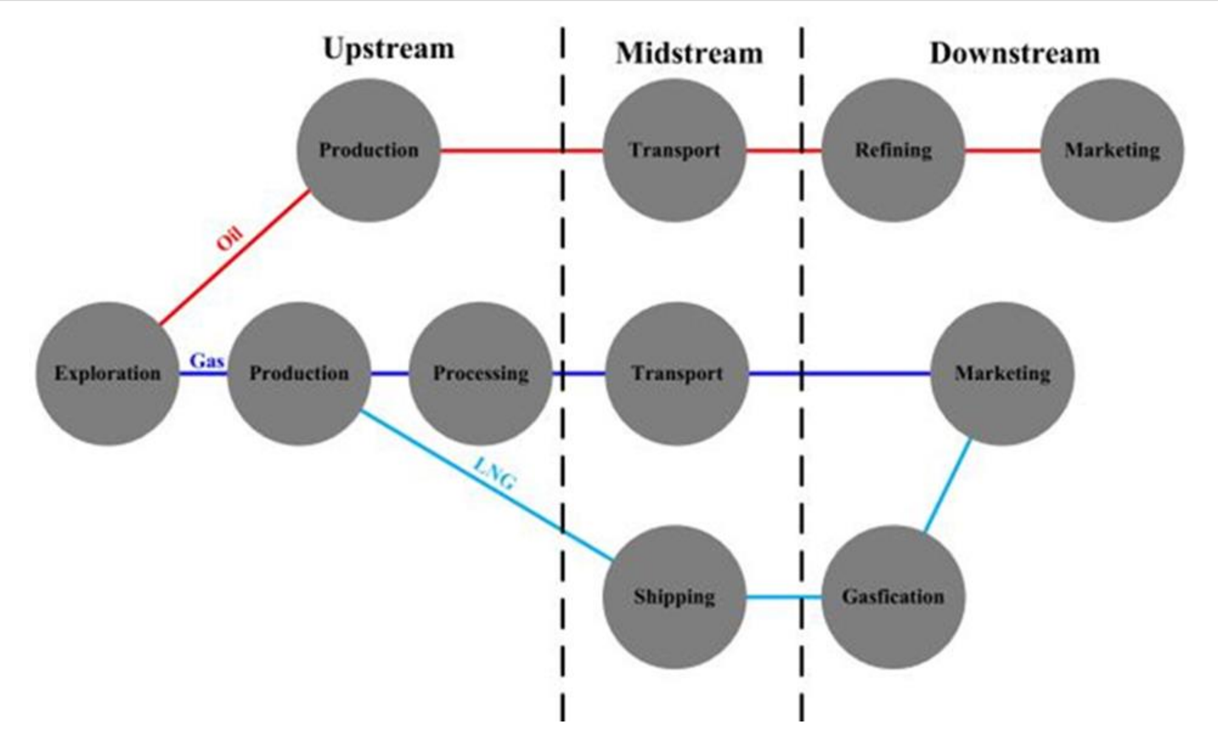

Figure 3. Value chain in the oil and gas industry (Lu et al., 2019).

The blockchain in the oil and gas industry has excellent potential in trading, management and decision-making, monitoring, and cybersecurity, according to the reports issued by Deloitte in April 2017.

Trading: The use of blockchain technology in the oil and gas trade mainly includes smart contracts and transactions.

Management and decision-making: Many oil and gas industry decisions require a level of management to vote, and smart contracts in the blockchain enable automated and transparent voting.

Monitoring: Through blockchain technology, goods can be tracked throughout the route. Due to the high transparency of the blockchain, this technology can improve compliance in oil and gas and help capture information without change or deletion.

Cyber security: Blockchain technology can solve security problems, including the complex operating system and production process, interoperability of Information Technology (IT) and operation technology (OT), and real-time system delays caused by Redwall, incompatibility of network standards between departments Solve irregular updates of system security patches (Lu et al., 2019).

4. Maturity Model

The maturity model is a set of characteristics, attributes, indicators, or patterns representing progression and achievement in a particular domain or discipline. Model components are typically arranged according to a specific pattern and procedure and are reviewed by operating applications and calibration. The maturity model allows the organization or industry to evaluate practices, processes, and methods against a clear set of factors and achieve a criterion. Maturity models typically have "levels" and evolutionary scales that indicate the change from one level to another. Characteristics define each level, and the achievement of capabilities transports the organization from one matured level to another. Having measurable transition states between the levels enables an organization to use the scales for the following:

- Defining the current state
- The framework of essential activities
- Determining the future and organization maturity
- Identifying the attributes that it must attain to reach that future state (Caralli et al., 2012).

Using the maturity model on the one hand as a basis for organizational improvement processes, methods, and performance, and on the other hand, to compare performance in a specific field for organizations have the following benefits:

- Setting internal performance criteria
- Accelerating organizational performance improvement
- Accelerating the improvement in the performance of all organizations in a specialized field
- Creating a standard benchmark for comparing similar organizations (Stevens, 2014).

4.1. Types of Maturity Models

In many cases, managers and owners of companies, especially at critical times in a company's life, need to know what level their company is from a particular perspective (e.g., attention to strategy, innovation, security, and marketing policies). In order to meet these needs, organizations can use maturity models to determine their current level of achievement or capability. On the other hand, these models become the basis for measuring the performance of organizations. They can be used to create a variety of applications.

In general, maturity models can be categorized into three types:

- Progression Maturity Models
- Capability maturity Models
- Hybrid Maturity Models

4.2. Capability Maturity Model (Process)

In the capability maturity model, an aspect of organizational capabilities is measured that represents a set of "process" characteristics, indicators, attributes, or patterns. Hence, the capability maturity model is often referred to synonymously with "process models". Also, this model is a tool to improve the quality of organizational processes. This model identifies the organization's strengths and weaknesses and provides a framework for turning process weaknesses into strengths. This model is a set of superior experiences of successful organizations in the area of organizational process management. In the capability maturity models, the "levels" describe organizational maturity states relative to process maturities. As a result, the models like CMM for services have emerged for improving performance. The organizational maturity models are widespread, designed, and implemented based on one or more maturity models. In Table 2, the following maturity models in information technology are tabulated (Caralli. et al., 2012).

Table 2. Organizational maturity models in the area of information technology.

Area	Models
Information Technology	Capability Maturity Model
	Open-Source Maturity Model
	Maturity Model of System Integrity
	Maturity Model of Performance Management Applications
	Richardson Maturity Model

The Capability Maturity Model (CMM) is one of the most popular models. This model was first used to evaluate the software production process, developed for over 20 years. It is also widely accepted as a general maturity model in business, commerce, industry, and IS/IT organizations (Herblesb et al., 1997). In other words, the capability maturity model (CMM) is the essential basis of IS's past research on maturity models (Poppelbub et al., 2011).

On the other hand, the organizations in this area must ensure that their needs for using technology are in line with the organization's framework. To emphasize the importance of this compatibility, organizations need to be aware of their business plan communication strategy and information. Parsons proposed six strategies in this regard. Each of the six different strategies devises an approach in which the organization can create IT goals and objectives, evaluate projects, allocate resources, and set performance standards (Jafarkhani 2009). This is a possibility that can be realized by blockchain technology in the organization.

4.3. Blockchain Maturity Model

The implementation of blockchain technology introduces new and specific risks that do not exist in more traditional centralized systems. So moving from the proof-of-concept phase to production can be very challenging. The blockchain maturity model helps organizations assess the IT readiness to implement blockchain by identifying specific risks and opportunities before production begins. The KPMG maturity model is a blockchain-based on the Integrated Capability Maturity Model (CMMI). This maturity model is an integrated capability model owned by the Information Systems Auditing and Control Association (ISACA), an international professional Institute for IT governance. The integrated maturity model uses five maturity levels to measure maturity (KPMG, 2018).

4.4. Maturity Model Levels

In Figure 4, the steps of the organizational blockchain maturity model are presented. According to the figure, the first stage is emerging. At this level, time is spent learning about blockchain and the opportunities it brings. partnership networks have not emerged yet. The next stage is the identified level. When an organization is actively planning blockchain projects, it is at the maturity model's identified level. At this stage, the organization is actively developing its Proof of Concept on the selected platform and collaborating with the business network towards joint projects. When an organization actively implements a blockchain solution, the organization moves to the maturity model's defined stage. At this level, it develops Proof of Concept in a particular context. The workforce experience of the organization begins to create an appropriate model within its business network. If an organization's blockchain technology production program brings the previous level to the production stage, the blockchain maturity model's levels have evolved into the Operational level. At this stage, the partnership network is working at full capacity, the organization's workforce experience and the organization's business partners are joining the existing partnership network. Furthermore, when the blockchain program is entirely generated and lived, the organization is in the blockchain maturity stage. In this stage, the organization's partnership network operates at full capacity, and other partners are joining the initial partnership network. So far, none of the organizations have reached maturity, as the first programs did not live long enough to optimize the participation network. There were no almost self-governing and fully autonomous organizations (Simula, 2018).

Figure 4. The blockchain maturity model (Simula, 2018).

5. Methodology

In this qualitative study, first, the literature and background of the blockchain maturity model are reviewed. Then the research conceptually model is presented using a semi-structured interview with experts in the blockchain area and analysis of interviews using the Grand Theory method (in three stages of open coding, axial coding, and selective coding). Since identifying the risks and challenges of the blockchain technology maturity model has not yet been fully explored, and most research in this area has focused only on specific dimensions of blockchain variables, grounded theory for research is the best choice. The research model's initial framework for collecting data was a library study of the subject and background literature. Therefore, the theoretical part of the subject was studied by referring to books, journals, publications of research and research centers, related academic thesis, searching in electronic databases, and using Mendeley desktop software. Then, through interviews with experts in blockchain, risks and challenges are identified, and a conceptual model is presented. Simultaneously, through theoretical sampling, data is collected, coded, and analyzed and to drive towards a theory or hypothesis, from the initial findings, this theory decides what the next information is needed and where it should be collected. Accordingly, in this study, 12 experts were interviewed and from the tenth interview onwards, repetition was observed in the information received, but to be sure, it continued until the twelfth interview. The reliability of the interviews was investigated using Test-Retest Reliability methods and Internal Consistency Reliability. We selected three interviews and coded each twice by a researcher within a 10-day interval using the retest method. The retest reliability was equal to 0.93, and since it was more than 0.60, it was considered acceptable. Then, using the agreement method within the two coders' subject matter, another researcher was requested to participate in this section. After conducting the necessary experiments on coding techniques, three interviews were coded again by the researchers. The reliability of the coders in this study was calculated to be equal to 0.90. Since it was more than 0.80, the coding reliability was confirmed; thus, it can be claimed that the interview reliability is appropriate (Kvale,1996).

5.1. Analysis of Interviews

Using coding, we performed the conceptualization, dimension reduction, and determination of categories by the characteristics and dimensions, relevance, or relativization of categories to interpret and organize the data. Moreover, the data analysis from the interview with blockchain experts, including the analysis and interpretation of the concepts expressed based on open, axial, and selective coding, was performed as follows:

Step 1: Open Coding

The concepts obtained from the interviews and documents were classified based on the relationship with the blockchain maturity model. As a result, key points and topics were coded with the information obtained from expert interviews.

Step 2: Axial coding

At this stage, the categories created in the previous step were expanded based on the paradigmatic pattern.

Step 3: Selective coding

The main categories were systematically linked to other groups and presented within a model framework. Therefore, for qualitative data analysis, the coding process was as follows:

After introducing the research's topic and aims, the experts were asked the interview's initial questions about the dimensions and levels of the blockchain technology maturity model.

After analyzing the initial answers, questions arose. Subsequent inquiries related to emerging issues were developed, that the following interviews were focused on them. This process was continued until the theoretical saturation. Each interview was reviewed to extract key points and open coding. Then, the crucial points were identified, and new codes were assigned using the fixed comparison method. They were also compared with open codes in previous and similar versions to determine if they were new or previously created. For example, some of the comments in response to the interview questions were coded as follows:

In the initial stages and emergence, the organization does not yet have a strategy. Thus, the support of managers performs a vital role in the initial stage. In other words, what matters is the support of managers for an organization that is ready to change and adapt to technology.

An organization with a spirit of changeability, readiness, and courage to use technology is a learner that connects with the outside world and participates in market trading. This part of the interview clearly described the elementary level and emergence. In the maturity stage, the strategy achieved its goals. The business model of the organization was changed entirely. At this stage, the business model of the organization was strengthened and completely changed. The training was wholly specialized and based on blockchain. The blockchain network ultimately worked together. Consensus took place in the organization. Transparency in the areas that benefit from this technology was very high; its culture was utterly based on blockchain technology and aimed to strengthen and approve it. The interests of internal and external stakeholders were fully realized. This section of the interview pointed to the mature blockchain level in the organization. The continuation of the open coding process and the frequent use of constant comparisons led to the formation of features, dimensions, and categories. A higher level of data categorization involves several related concepts. Glazer (1978) hypothesized the report's theorization of actual codes' ideas and coded relationships that emerged during coding, data collection, and analysis. When the theoretical saturation is realized, theoretical coding or theorizing, the last step in data analysis, has begun, in which the researcher seeks to find relationships between the main categories. Summary of open and axial coding results based on each respondent's opinion is presented in Table 4.

Table 4. Frequency of categories and subcategories of blockchain maturity model levels.

Frequency	Open & Axial Codes
1074	Model levels of blockchain technology maturity
227	Emerging
-	Preliminary studies
23	Narcissism
26	Cooperation & Participation
36	Technology monitoring
32	Ready for change
15	Managers' skepticism
22	Initial consultation
19	Lack of blockchain strategy
36	Basic training
18	Lack of platform
238	Identified
-	Acceptance assessment
25	Review solutions
-	Selection of applications
25	Technical
17	Business process management
25	Business model
14	Consortium
16	Changing the mentality of managers
12	Cognitive counseling
-	Applied consortium

Frequency	Open & Axial Codes
20	Forming a consortium
10	Cooperation & participation
19	Applied strategy
16	Educational requirements
17	Platforms evaluating
-	Regulatory evaluation
22	Cognition of rules and regulations
133	Defined
12	Passion of managers
-	Additional advice
9	Feasibility
15	Proof of Concept (POC)
11	Consulting services
19	Duty Consortium
24	Develop a roadmap
15	Educational textbook
15	Platforms description
13	Codify rules and regulations
233	Operational
14	Managers' risk-taking
14	Technical advice
15	Technical consortium
19	Results-oriented strategy
-	Specialized training
17	Technical training
10	Skilled force
15	Platform selection
11	Attention to regulatory

Frequency	Open & Axial Codes
22	Resistance
-	Organizational change
27	Roles and processes
20	Business model
15	Connections
18	Infrastructure
16	Funding
243	Matured
11	Members consensus
-	Coalition of Partner Organizations
16	Blockchain consortium
15	Cooperation & participation
11	Develop and modify strategies
24	Skilled workers training
-	Blockchain business model
14	Native platform
23	New business model
12	DAO (Decentralized Autonomous Organization)
-	Maturity requirements
18	Blockchain culture
11	Strong government
12	Full data control
15	Compliance with regulations
12	Standardization
9	Authentication
11	Security against fraud
10	Reliability
10	Scalability

Frequency	Open & Axial Codes
19	Stakeholder’s satisfaction

According to Table 4, 38 categories and 36 subcategories in the axial codes of emerging, identifying, defined, operational and mature, have been determined. Based on the results of the selective coding, the obtained conceptual model of the research is shown in Figure 5.

Figure 5. A conceptual model based on the interview analysis.

According to Figure 5, the conceptual model of the different levels of the blockchain maturity model was drawn based on the interviewees’ opinions at the five levels of emerging, identified, defined, operational, and matured. These levels are drawn based on strategy, training, collaboration, participation, consortium, managers desire, platform, rules and regulations, consulting services, funding, and new indicators expressed during the expert interview.

6. Discussion

The rapid development of blockchain technology and its various applications has rendered it essential to understand its adoption guidelines. In this direction, one of the methods is the analysis of the ability maturity model. Therefore, this study can play an essential role as a guide for organizations to make more systematic decisions about the level of readiness and adoption of the blockchain. After conducting this research, the following results and findings were extracted:

The emerging level shows that experts emphasize the technology monitoring index with a frequency of 36 and the category of basic blockchain training in organizations with a frequency of 36 more than other indicators. From an expert's standpoint, the important note is that many organizations are Narcissism in confronting blockchain technology. This means that without deep study and review of the technology's application in their organization, they act hasty and thus incur high costs and become frustrated with its adoption and use. At the identified level, the organizations' acceptance assessment of blockchain technology focused on reviewing solutions and selecting applications. In the Review solutions section, organizations are looking to solve their problems based on blockchain technology features. Also, in the application selection section, organizations select appropriate applications after ensuring that this technology has the potential and ability to provide the right solution to their problems. These applications are classified into technical, business process management, business model, and consortium (industry).

According to this type of technology, each organization seeks appropriate solutions. Hence, from the experts' viewpoint, the solution is considered in the acceptance assessment of blockchain technology with the frequency of 25, and the selection of applications of this technology in the technical layers and the business model with the frequency of 25 has drawn attention more compared to the other layers. At this level, another important point from the experts' viewpoint is cognition of rules and regulations of the government with a frequency of 20.

At the defined level, the most crucial indicator from the experts' point of view is developing a blockchain technology strategy, developing a roadmap with a frequency of 24. The critical point at this level is the feasibility of this technology through the formulation of proposals and justifications, and proof of concept (POC). Proof of concept is a kind of exercise in which it is determined whether an idea can become a reality or not!

At the operational level, many experts (22 people) emphasize that at this stage, due to the implementation of blockchain technology and thus eliminating intermediaries and increasing transparency in the organization, many managers, employees, stakeholders, and even organizational structures resist the adoption and implementation this technology. From the experts' standpoint, in this technology, the paramount is to pay attention to specialized and technical training in blockchain in the organization. Also, at this level, new rules and regulations may prevent blockchain implementation. At the matured level, the experts emphasize that at this stage, consortia are faced with accepting new members and possibly leaving old members with the frequency of 16. Also, they emphasize that as a result of planning and training that was done in the previous levels and stages, organizations at this stage have skilled and specialized people in the field of blockchain, which is one of these skilled forces to train people in Benefit departments or partner organizations with the frequency of 14. From the experts' standpoint, one of the characteristics of maturity in the blockchain is the ability and potential of maturity requirements in organizations. With the frequency of 19, the satisfaction of stakeholders by increasing the profit and added value for them and shifts in perspective and Blockchain culture in organizations with the frequency of 18 are the two most crucial maturity requirements. The critical point in this stage from the experts' point of view is the existence of a blockchain business model based on the consensus and participation of all members in the organization's decision-making and the existence of local and unique platforms of organizations

Based on the obtained results, some suggestions can be made for future research:

- Considering maturity models of integrated capability, open-source, system integrity, application performance management, and Richardson as an independent study examining the blockchain maturity model can have meaningful results for organizations.
- Paying attention to the blockchain technology applications in the value chain can provide a good context for future independent research at three levels: upstream, midstream, and downstream of the oil and gas industry.

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