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Identification and Ranking of Key Factors for Successful Block chain Deployment in the Supply Chain of Iranian MAPNA Boiler and Equipment Engineering and Manufacturing Company

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Abstract

Many studies, particularly in international literature, have addressed the utilization of this highly beneficial technology in the supply chain. Therefore, the current study is an effort to study block chain technology to develop the application of the modern supply chain in contrast to the traditional one. This research was carried out with the purpose of identifying the components of key success factors for block chain, focusing on opportunities and the impacts of these factors alongside modern technology. It seeks to prepare MAPNA Boiler and Equipment Engineering and Manufacturing Company to confront the chaotic trend of challenges during the age of the Fourth Industrial Revolution. Regarding its objective, this study is applied in nature, and with respect to the data collection approach, it is descriptive. For data gathering, qualitative methods including expert interviews and content analysis were utilized. In the quantitative section, a questionnaire was employed with a statistical population comprising a number of experts in this field at MAPNA Boiler Company. The result was the identification of 41 factors categorized into 7 main groups. Ultimately, using the Pairwise Comparison Matrix (Weighted Sum Vector) and the Step-wise Weight Assessment Ratio Analysis (SWARA) technique. According to the results, the most important components such as data quality, speed, process simplification, system guidance and control, system productivity, security, and transparency were ranked.

Keywords: Supply Chain Management, Nominal Group Technique, Step-wise Weight Assessment Ratio Analysis (SWARA), Block chain.

Paper Type: Original Research

1. Introduction

Nowadays, alongside the progress of technology and the definition of new strategies, as well as the growth of companies in both size and capital, organizations are shifting from function-oriented to project-oriented structures. Consequently, leveraging new technologies has become essential for the survival of any organization in facing complex business challenges. This trend is also evident in organizations such as MAPNA Boiler and Equipment Engineering and Manufacturing Company, which places a strong emphasis on various types of projects and manages most of its activities within a project framework. This company operates in the design, procurement, manufacturing, installation, and commissioning of various types of heat recovery boilers and cogeneration (Combined Heat and Power - CHP) systems, along with related ancillary equipment. It serves the power, oil and gas, petrochemical, water, and other industrial sectors in both domestic and international markets, operating on an EP (Engineering and Procurement) and EPC (Engineering, Procurement, and Construction) basis. Identifying and achieving the key success factors for projects at MAPNA Boiler Company Can play a determinative role in elevating the organization's performance by reducing the probability of failure and associated costs. Therefore, the objective is to find effective criteria for supply chain success by leveraging the concepts of blockchain. Blockchain is an immutable technology, immune to intentional alteration, employed in a collaborative and integrated setting where all transactions are verified by users and are traceable. This creates a decentralized setting where every network member can interact securely without requiring a reliable central authority. Therefore, by verifying and storing all transactions via distributed consensus, it eliminates the need for a central entity (Min, 2019; Fu and Zhu, 2019a). In this research, the main emphasis of the investigators is on identifying and prioritizing the core success factors for blockchain adoption in the supply chain of MAPNA Boiler and Equipment Engineering and Manufacturing Company.

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2. Concepts and Theoretical Foundations

Blockchain architecture is composed of a sequence of linked blocks, enabling the transparent and dependable tracing of transaction histories via prior blocks. Every blockchain unit contains a distinct code aligned with the hash signature of the preceding segment, a mechanism that safeguards transaction integrity. Transactions undergo verification and documentation by every network participant, are marked with timestamps in a sequential timeline, organized according to their sequence of events, and remain unalterable after being incorporated into the chain. This framework establishes blockchain as a fundamentally reliable technology (Queiroz et al., 2019). One of the most significant features contributing to the trustworthiness, confidentiality and clarity within blockchain is the concordance mechanism. In this mechanism, the records of each block are registered using embedded hash codes, and the determination to incorporate a new block is made through the consensus of the network members (Pankaj Dutta et al., 2020). This characteristic makes blockchain an effective tool for tracking and monitoring the supply chain and achieving key operational success factors (Khosla et al., 2019). Based on the results of Wang et al. (2019), blockchain can elevate the degree of information exchange, refine documentation oversight, and increase data accessibility. Furthermore, in the industrial sector (Fernandez-Caramés et al., 2019), this technology has been put forward as an answer for the distributed organization of data through an accord protocol (Gao et al., 2018; Benčić et al., 2019). Blockchain holds the potential to bring about fundamental transformations in supply chain management by improving clarity, authenticity, trust, and security, while simultaneously reducing costs, eliminating intermediaries, increasing operational efficiency, and minimizing surplus discard (Philipp et al., 2019; Gurtu and Johny, 2019). Moreover, all blockchain-based transactions are inherently more efficient, secure, economical, and transparent (Queiroz et al., 2019), and its distributed nature can Serve as a critical component of mitigating supply chain risks. In addition to the aforementioned points, the implementation of automated contractual protocols on the blockchain platform enables the instant settlement of orders and the automation of production operations (Sheel and Nath, 2019). This technology also enhances the adaptability, agility, and resilience of operational networks by reducing the bullwhip effect in the supply chain and creating controlled disruptions resulting from paradigm shifts (Chang et al., 2019a; Wang et al., 2019a; Saberi et al., 2019a; Surjandy et al., 2019a; Shamout, 2019; Narayanaswami et al., 2019). (Chang et al,2019a; Wang et al,2019a; Saberi et al,2019a; Surjandy et al,2019a; Shamout,2019; Narayanaswami et al,2019). Table 1 presents key advantages associated with integrating blockchain into supply chain operations.

Table 1. Advantages of using blockchain in the supply chain (Pankaj Dutta et al,2020)

Functional Aspects of the Supply Chain	Description
Supply Chain Resilience	• Mitigates the impact of disruption by using "proactive" measures for risk management and creating multi-layered protection for the supply chain network. • The inherent design of blockchain enables the reduction of risks within organizational and network domains.
Supply Chain Provenance	• Offers the capacity to authenticate, monitor, and follow product information.
Supply Chain Re-engineering	• Increases supply chain transparency and visibility, enabling process automation. • Removes the need for intermediaries and facilitates real-time tracking by leveraging methods in traceability, data privacy, and information handling.
Enhanced Security	▪ Facilitates secure authentication, preserves confidentiality and privacy, and manages data access to ensure service integrity. ▪ Blockchain contributes to heightened security, employs a consensus mechanism enabling flexible data storage, and improves transparency with robust data protection, improves reliability, and aids in cost management.
Business Process Management	▪ Enables efficient business process management through smart contracts by consolidating t control flow and business logic of inter-organizational business processes. • Effectively impacts asset management and customer order process management, which i proves the efficiency, tracking, and visibility of orders.
Production Management	▪ Enhances key performance indicators, including operational cycle time, output, and quality, and allows for product distinction via comprehensive integration with the supply chain.• Assists in price determination and tracking during product distribution to the terminal stages of supply chains.

In international commerce, the oversight of the supply chain assumes a pivotal function in mitigating operational expenditures (Gunasekaran et al., 2004). Every manufacturer wants to provide their goods to consumers at the lowest possible price. Blockchain technology is regarded as an innovative instrument with the objective of reducing expenditures (Catalini and Gans, 2016) and quality improvement. These nuanced advantages of blockchain strengthen the supply chain and motivate the integration of blockchain into supply chain management (Korpela et al., 2017). Their primary focus was on improving organizational performance and achieving cost-efficient production through data protection and transactions, distributing the nature and transactions across peer-to-peer networks. The supply chain is considered a broad sector and a fundamental infrastructure for any industry (Hughes et al., 2019). However, traditional supply chain systems are not sufficiently diverse or transparent to meet the growing needs and demands of the future, and they incur high costs in terms of error management, expenses, administration, and fraud (Pankaj Dutta et al., 2020). The supply chain is becoming increasingly complex for various reasons, such as human error (Finch, 2004), service disruptions, and climate change (Halldórsson and Kovács, 2010; Popper and Lohr, 2017). Damage, misplacement of goods, time consumption, and fraud have a direct outcome on both the manufacturer and the retailer. Blockchain technology helps improve clarity, security, traceability, and cost control from the manufacturer to the end-user, through the network of suppliers and retailers (Banerjee, 2018). In many cases, customers and end-consumers lack sufficient awareness of the processes, the flow of goods on production lines, and the risks and issues associated with manufacturing, transportation, and handling (Anjum et al., 2017). Blockchain must ensure the accuracy, validity, and verification of information throughout this entire chain. These forms of incidents lead to the emergence of new technology in the production and supply system. The use of blockchain offers benefits such as security, immutability, distribution, clarity (Chiaroni et al., 2019), and accuracy (Iansiti and Lakhani, 2017; Saberi et al., 2019). Table 2 presents the characteristics of blockchain based on the studies conducted.

Table 2. Description of Blockchain Characteristics Sachin Yadav, Surya Prakash Singh 2019

Code	Components	Characteristic	Author(s)	Description
A1	Data Quality	Quality Assurance	Weber et al., 2016 Lucena et al., 2018 Benchoufi and Ravaud, 2017 Dai and Vasarhelyi, 2017	This feature provides businesses with a better environment for research and for leveraging expert guidance, thereby empowering them to initiate a pivotal advance in securing uninterrupted production processes and the provision of premium-quality goods and services.
A2		Reliably accurate data	Weber et al,2016 Sullivan ,1999 Azaria et al,2016	Blockchain ensures the maintenance of complete, consistent, timely, and accurate data, providing 100% accurate and valid information across the network, devoid of human processing errors.
A3		Fair Quality	Weber et al,2016 Iansiti and Lakhani,2017	This feature ensures that the data exchanged between different nodes is free from bias and human error, possesses complete transparency, and contains no hidden information regarding goods, suppliers, or other components of the supply chain.
A4		Cost	Bashir, 2017; Catalini and Gans, 2016 King and Nadal, 2012 Wüst and Gervais, 2018	Simultaneously, the exclusion of mediating parties substantially reduces overall expenses, overhead costs for asset exchange are reduced by 15% due to low transaction fees.
A5		Reliable System	Anjum et al., 2017	Through blockchain technology, the origin of a product is conveyed via real-time presentation and continuous updates.
A6	Process Simplification	Ecosystem Simplification	Bartling and Fecher,2016	These capabilities streamline the network structure within the operating environment, thereby mitigating the complexity stemming from numerous independent ledger systems.
A7		Simplification of Current Paradigms	Bashir, 2017	This feature enables the blockchain to act as a single, shared ledger among stakeholders. Consequently, by eliminating the complexities arising from multiple and diverse frameworks—each maintained by different entities—cohesion and integration are established within the model, and its functionality is optimized.
A8		Disintermediation	Bogart and Rice, 2015 Bartling and Fecher,2016	Built upon a distributed ledger, the **Public Blockchain paradigm** operates with inherent **autonomy** and requires no central governing body or administrative oversight for data transmission protocols. Furthermore, transactional data is not archived in conventional storage modalities, such as centralized database infrastructure; rather, records are secured via **distributed archival** across all participating network nodes.
A9	Speed	Disintermediation and Removal of Intermediaries	Pankaj Dutta et al,2020 Weber et al., 2016 Gatteschi et al., 2018	It results in a continuum of seamless transactional activities. It increases speed. It enhances trust among process stakeholders. Blockchain establishes the structural basis for a direct transaction without the involvement of intermediaries or third parties.
A10		Speed	Zhu and Zhou,2016	This capability is particularly essential for products that have a very short life cycle and require precise management, such as certain chemicals, vegetables, and fruits. In such conditions, blockchain-based supply chain management can lead to product conservation and quality preservation by optimizing the flow of information and processes.
A11		Improved Response Time	Pankaj Dutta et al,2020	By making better use of its resources, it creates a dynamic and real-time supply chain.

A12	System Guidance and Control	Auditability	Shafagh et al., 2017 Azaria et al., 2016	Blockchain technology serves as a permanent repository for the entire transaction history. This functionality inherently enhances the efficiency of access, management, and controllability of the data.
A13		Smart System	Bitfury Group, 2015 Iansiti and Lakhani,2017	Time-consuming transactions can hinder the development of a business. With **smart contracts** and agreements, transactions can naturally be verified, specified, and supported through the blockchain.
A14		IssueIdentification and Integrity	Michal et al,2018 Tian,2016 Drugs ,2004 Mangla et al,2019	Integrating blockchain provides real-time visibility into any supply chain inventory issues, drastically reducing human error across the system.
A15		Feedback	Peters et al,2015 Foroglou and Tsilidou,2015	By having the capability for complete traceability of a product throughout its lifecycle, along with access to reverse-flow information during the stages of re-installation, initial installation, maintenance, and operation, it becomes possible to enable precise monitoring and process optimization. Furthermore, for every transaction ever conducted, a distinct and verifiable record is maintained on the blockchain, which ensures transparency and trust among all stakeholders.
A16		control	Swan, 2015 Korpela et al., 2017	This characteristic transforms the blockchain into a distributed ledger system, which then serves as the secure storage mechanism for all essential data.
A17		Automation	control Bartling and Fecher,2016 Li et al,2019a Pankaj Dutta et al,2020	Contract automation refers to the use of a small computer program designed and implemented to facilitate and ensure the execution of contract terms. It substitutes the function of customary contractual frameworks by providing better security and lower transaction costs. Smart contracts are typically coded to include conditions for rules, penalties, and actions that will apply to all parties involved in the transaction. Smart contracting supports quick-response operations in supply chains.
A18		Decentralization	Zyskind and Nathan,2015 Anjum et al., 2017 Iansiti and Lakhani, 2017	Non-centralized: The data within the system can be accessed, monitored, stored, and updated across multiple systems. Each node in the blockchain can securely access, transfer, store, and update data without the intervention of a third party
A19		SmartContract Management	Pankaj Dutta et al,2020	Custom and dedicated contracts can be independently defined for each function and cohesively coordinated with one another. This capability plays an effective role in designing processes related to business operations, and while enhancing transparency and managerial visibility, it eliminates the need for intermediaries.
A20		Information Management	Pankaj Dutta et al,2020	It facilitates the calibration of data located in different supply chains. It Strengthens the security of stored data. The recording of all information is done in real-time.
A21	System Productivity	Energy	Zhang et al,2018 King and Nadal,2018	Blockchain contributes to savings in energy and resources through: reduced tracking time, easier process control, paper savings, and transportation optimization via real-timmove feedback, etc.
A22		Addressing the issue of transactional duplication	Bartling and Fecher,2016 Lundqvist et al,2017	Double-spending means that the same data/transaction cannot be sent to two or more people simultaneously. A peer-to-peer transaction is authenticated after confirmation by an authorized party.
A23		Productivity	Ahram et al,2017 Smetana et al,2018	Smart contracts offer superior traceability, which profoundly streamlines operational processes, leading directly to significant reductions in both time and monetary expenditure.
A24		Reduction in Administrative Costs	Bashir ,2017 Catalini and Gans, 2016	Reduced paper usage, time savings, facilitation of discussions and exchanges, enhancement of management quality, and utilization of a shared database all translate to a reduction in administrative workload and an increase in organizational productivity.
A25		Inventory Improvement	Korpela et al,2017 Lucena et al., 2018	This blockchain feature simplifies inventory management by providing everyone with a copy of the data.
A26		Operational Efficiency	Pankaj Dutta et al,2020	This capability enhances the speed of completing supply chain processes and, by enabling early identification of existing problems, provides the foundation for strengthening and optimizing the operational workflow.
A27	Security	Scalability in Supply Chain Management	Scherer, 2017 Madavi, 2019	After information is added to a blockchain, it acquires an immutable and tamper-proof nature; moreover, the use of a dedicated and distributed storage structure makes digital attacks extremely difficult and costly.
A28		Security	Iansiti and Lakhani ,2017 Kshetri, 2018	Once a block is forged, its deletion or alteration is rendered virtually impossible. This distinguishing attribute profoundly augments the security echelon within the supply chain through the integration of blockchain technique into the existing traditional methodologies..

A29		Durability, Reliability, and Longevity	Niranjanamurthy et al,2018 Saberi et al,2018 Weber et al,2016	This technology substantially reduces the likelihood of systemic breakdown, data loss, malicious attacks, and conflicts between central authorities. All transaction records and information related to the data flow are authenticated and protected under advanced security measures.
A30		Traceability, Visibility, and Direct Invoicing	Koch, 2016 Rob Price, 2015 Everledger, 2016	Each purchase order is recorded and presented as an essentially immutable block in the chain, ultimately simplifying supply chain management.
A31		Rules	Werbach, 2018; De Filippi, 2018; De Filippi and Hassan, 2018	Smart contracts allow valid transactions to be carried out automatically, removing the need for a middleman.
A32		Government Policy	Ølnes et al,2017 Luthra and Mangla,2018	This issue is considered one of the fundamental challenges facing organizations operating in the supply chain. Utilizing this capability allows for the rapid identification of fraudulent cases during any organization's audit process.
A33		Immutability and Recording	Weber et al,2016 Saberi et al,2018 Pankaj Dutta et al,2020	Once a transaction or data transfer is confirmed, it becomes immutable. Also, any changes to the blockchain can only be stored with network consensus.
A34		Intellectual Property Management and Uniqueness	Pankaj Dutta et al,2020	Every document on the blockchain is linked to its owner through a unique cryptographic hash.
A35		Near-Impossible Data Loss	Weber et al,2016 Madavi,2019	Blockchain architecture makes the compromise or loss of stored information practically infeasible, owing to the presence of a complete dataset duplication at every node.
A36		Accounting	Dai and Vasarhelyi,2017	Transactions recorded on a blockchain platform minimize human errors and, by utilizing cryptographic mechanisms and a distributed architecture, guarantee data security against hacking attacks and various potential interferences.
A37		Customer-Centricity	Raju et al., 2017 Tian, 2016	Trust in the supply chain and precise knowledge of the source of production are of vital importance to any manufacturer. Achieving this goal is possible through the provision of continuous, "live," and reliable updates, which enables access to the credible and historical records of providers and enhances transparency throughout the entire chain.
A38	Transparency	Data Accessibility	Ølnes et al., 2017 Liang et al., 2017	In a network based on a distributed ledger, thousands of nodes operate in a decentralized manner, and data always remains available. This feature allows transactions to be executed at any time; because even if one or more nodes fail or go offline, the continuity of operations is guaranteed owing to the extensive availability of data across the entire network.
A39		Information Flow and Control	Korpela et al,2017 Saberi et al,2018	Blockchain technology facilitates the collection of customer feedback in real-time. This continuous feedback is relayed to retailers and manufacturers, assisting them in making more accurate forecasts and improving operational processes.
A40		Transparency	Nugent et al ,2016 Iansiti and Lakhani,2017 Pankaj Dutta et al,2020	This mechanism leads to the final verification of peer-to-peer transactions at the end of the process, ensuring their accuracy and validity. And the updated data cannot be changed or hacked. The feature of blockchain to change anything in the ledger that remains afterward makes it a transparent system.
A41		Collaborative Demand in Supply Chain Management	Ølnes et al., 2017 Tian, 2016	Joint demand" in supply chain management means the sharing of information flow regarding the processes of maintenance, procurement, production, regulation, and assembly, from the manufacturer stage through to suppliers and vendors.

3. Research Methodology

The present study is applied in terms of its objective and descriptive in its methodology. The geographical scope of this research is MAPNA Boiler and Equipment Engineering and Manufacturing Company, and the statistical population consists of 10 available experts within the company in the specialized domain, who were selected using the theoretical saturation method for the data. The selection criteria for the experts included age, work experience, and educational degree, as detailed in Table No. 4. In this section, all components extracted from the articles, as well as the opinions of the experts, were categorized using the Nominal Group Technique (NGT). For this purpose, experts with the characteristics mentioned below were utilized to achieve the best categorization and/or to eliminate non-essential components. The simplified research process was as follows: first, articles that used the keywords "supply chain" and "blockchain," or both, in their title or abstract were extracted. This search encompassed both domestic and international articles from the following websites over the last 10 years:

SID: 548 articles on "supply chain" and 1 article on "blockchain."

Scopus: 2 articles on "supply chain" and 1 article on "blockchain."

SCIENCE DIRECT: 4,556 articles on "blockchain," 269,125 articles on "supply chain," and 1,829 articles combining "supply chain - blockchain."

IRANDOC: 4 articles on "supply chain."

CIVILICA: 3,182 articles on "supply chain," 18 articles on "blockchain," and 1 article combining "supply chain - blockchain."

Then, by leveraging the opinions of experts and using content analysis techniques (software tools and modern text data mining methods), a number of the most important factors were extracted, and the key factors were categorized into domains. Subsequently, the components were ranked and categorized using the SWARA method and pair-wise comparisons. The implementation stages of this research are described in Table No. 3.

Table 3. Research implementation process

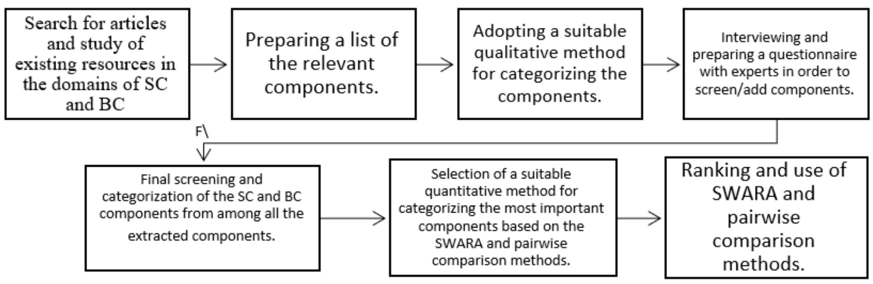

Table 4. Characteristics of experts

Education Level	Work Experience (Years)	Organizational Position/Department	Number of People
Doctorate (Ph.D.)	20-25	Factory Directors and Deputies	3
Master's Degree	15-25	Production Circle Managers	4
Bachelor's Degree	15-20	Quality and Services Group	3

Using the SWARA method, the following sequential steps were taken:

Categorization: In the first step, with the help of experts, all the components listed in Table No. 5 were divided into 7 main categories.

Table 5. Category

Components/Factors	Categorization of Components
Data Quality	J1
Simplification of Dynamics	J2
Speed	J3
System Guidance and Control	J4
System Productivity	J5
Security	J6
Transparency	J7

Research Findings

Since the second step in the SWARA method, namely ranking, plays a fundamental role in the subsequent weighting stages, a more precise method was used in this step. Specifically, the Weighted Least Squares (WLS) method, which utilizes pairwise comparisons, was used instead of the ranking technique typically used in the SWARA method (Mohammadi et al., 2019).

The Least Squares Method: Pairwise comparisons are used to compare the relative importance of criteria or even alternatives in relation to each other. If a Decision Maker (DM) wants to compare N criteria two by two (pairwise), they must evaluate and compare $Cn^2 = \frac{n!}{2!(n-2)!}$ cases.

In general, in this method, the following relationship is used to determine the elements of the matrix V:

$$\text{VIJ} = \frac{WI}{WJ}$$

Where WI and WJ are the unknown weights of the i-th and j-th criteria, but their ratio is represented as VIJ . In such a case, the overall matrix V for comparing n criteria is shown as follows:

$$\text{VR}= \begin{pmatrix} C1 & \frac{W1}{W2} = 1 & \frac{W1}{W2} & \frac{W1}{WN} \\ C2 & \frac{W2}{W1} & \frac{W2}{W2} = 1 & \frac{W2}{WN} \\ CN & \frac{WN}{W1} & \frac{WN}{W2} & \frac{WN}{WN} = 1 \end{pmatrix}$$

As can be observed, the aforementioned matrix is a square and reciprocal matrix in mathematics, where the elements of the lower triangle of the main diagonal are the inverse of the corresponding elements from the upper triangle of the main diagonal, and the elements or entries on the main diagonal are all one. The pairwise comparison table was formed from the perspective of the decision-makers (DMs), and to quantify the DMs' opinions based on relative priority, the scale from Table No. 6 was used. The even numbers are also placed in between the defined values.

Table 6. Relative priority spectrum

1	3	5	7	9
Equal Priority / Equally important	Moderate Priority / Moderately more important	Strong Priority / Strongly more important	Very Strong Priority / Very strongly more important	Extreme Priority / Extremely more important

At this stage, using the principles of the Analytic Hierarchy Process, the pairwise comparison matrix was formed based on the experts' opinions, and the result is detailed in Table No. 7.

Table 7. Analytic Hierarchy Process

Components	Data Quality	Simplification	Speed	Control	Productivity	Security	Transparency
	J1	J2	J3	J4	J5	J6	J7
Data Quality	1.00	4.83	2.63	0.43	2.71	0.58	0.80
Simplification	0.21	1.00	0.25	0.37	0.35	0.32	0.33
Speed	0.38	4.08	1.00	1.36	0.40	0.29	0.44
Control	2.34	2.72	0.73	1.00	2.35	0.58	1.33
Productivity	0.37	2.83	2.99	0.43	1.00	0.72	0.69
Security	1.72	2.61	3.39	1.72	1.39	1.00	1.55
Transparency	1.25	3.05	2.29	0.75	1.45	0.64	1.00

Assessing the Reliability of the Matrix Weights: To ensure that the weights have been extracted under acceptably stable conditions and would also be stable upon repetition, specific calculations exist, which are as follows. The Inconsistency Index of the Experts' Judgment Matrix: This index is obtained from the following relationship:

$$I.I = \frac{\lambda max - n}{n - 1}$$

Using the geometric mean for each cell, the geometric mean of all experts' opinions was calculated, and using the normalized matrix (row average method), the consistency vector and the inconsistency rate were calculated. The inconsistency rate must be less than 0.1 for the validity of the information to be tested.

Table 8. Incompatibility component

n	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Inconsistency Component	0	0/58	0/9	1/12	1/24	1/32	1/41	1/45	1/49	1/51	1/55	1/56	1/57	1/59

The inconsistency rate can be calculated as follows:

$$IR = \frac{II}{R.I.I}$$

The permissible limit of reliability has been set by Saaty at 0.1, therefore if in a matrix I.R>0.1, it no longer has the necessary stability, and the reason for it is the lack of expertise of individuals or a person from the expert team or possibly an error has occurred in recording the numbers within the matrix and it must be revised.

3. Determining Comparative Importance

In this step, the comparative importance of each component is calculated relative to the previous component. It is clear at this stage that the SWARA method's determination of comparative importance is dependent on the preceding component. For this reason, the method can be considered a chain-like and step-by-step process, in which the first component serves as the most important component and the benchmark for the rest of the components, determining the outcome of the other components and comparisons. The point of comparative importance here is that it is based on expert opinions, and there is no requirement for the sum of these comparative importances to equal one.

S1=∅ (Comparative importance of the first criterion)

4. Calculation of the Coefficient of Importance

In this step, the coefficient of importance is calculated for each component. For the first component, which serves as the basis for comparison, this coefficient is set to one. For the other components, the coefficient is obtained through comparison with the preceding component. Setting this coefficient to one for the first component is solely for the purpose of establishing it as the starting point for the calculations.

$$|Kj| = \begin{cases} 1 & J = 1 \\ Sj & J > 1 \end{cases}$$

SJ: The comparative importance of the j-th component.

KJ: The coefficient of importance for the j-th component.

5. Calculation of Weight

In this step, the weight of each component is measured relative to the weight of its preceding component. The weights are in a non-normalized form, and in this step as well, K1=1, which, according to the rule of non-normalized weight, means the weight for the first component is also equal to one, Q1=1.

6. Normalized Weight

The correction ratio of each ranked component is calculated relative to the total sum. For this purpose, the non-normalized weight of each ranked criterion is calculated [divided by] the total sum of non-normalized weights for each expert.

Wj : Normalized weight of the jjj-th component.

$$\mathrm{Wj} = Qj / \sum_{k=1}^{n} Qk$$

7. Final Weight

By aggregating the opinions of all 5 experts and using the arithmetic mean regarding the weight of each component, a conclusion can be made.

Table 9. Final Weights and Ranks

Component (Factor)	W1	W2	W3	W4	W5	Average Weight	Rank
Security	0/39	0/31	0/40	0/34	0/28	0/34	1
System Guidance and Control	0/19	0/21	0/20	0/23	0/21	0/21	2
Data Quality	0/16	0/17	0/15	0/18	0/16	0/16	3
Transparency	0/10	0/12	0/12	0/09	0/13	0/11	4
System Productivity	0/08	0/09	0/06	0/07	0/09	0/08	5
Speed	0/04	0.07	0.04	0.05	0.07	0.06	6
Simplification of Dynamics	0/03	0/03	0/04	0/04	0/05	0/04	7

"Consequently, the findings reveal that 'Security' emerges as the paramount success factor. Following in descending order of importance are 'System Guidance and Control,' 'Data Quality,' 'Transparency,' 'System Productivity,' 'Speed,' and 'Simplification of Dynamics.' These factors constitute the foundational pillars that MAPNA Boiler Company must strategically prioritize to ensure the successful implementation of blockchain technology within its supply chain."

8. Discussion

"A review of existing literature indicates that blockchain technology enhances transparency, security, traceability, and cost control throughout the supply chain, from the producer to the end-user via retailers. This capability is particularly crucial as customers and end-consumers are often unaware of the operational procedures, the flow of goods on the production floor, and the risks or issues related to manufacturing, transportation, and handling. This finding aligns with the results presented by Banerjee (2018). Furthermore, our research corroborates the necessity for blockchain to ensure the accuracy, validity, and verification of information, a conclusion that is consistent with the study by Anjum et al. (2017). The deployment of blockchain offers distinct advantages, including security, immutability, distribution, transparency, and accuracy. This conclusion is corroborated by the findings of Iansiti and Lakhani (2017) and Chiaroni et al. (2019), who also affirm its status as an innovative framework. Consequently, these inherent benefits create a strong incentive for the integration of blockchain infrastructure into supply chain governance mechanisms. In response to challenges posed by governmental regulations and evolving customer value demands, professionals across various fields are increasingly focusing on achieving sustainable supply chain management. Deploying blockchain across supply chains yields both efficiency gains and cost reductions, while advancing collaborative ties among participating entities. It fosters greater trust and simplifies related business processes. Furthermore, blockchain integration fundamentally transforms the supply chain structure by ensuring collaboration among all involved parties through digitalization and smart contracts. Considering that the critical success factors for blockchain are continuously evolving due to rapid technological advancements and ongoing research, it is plausible that more than the seven factors identified in this study exist. Therefore, future research could expand upon this investigation by exploring a broader set of factors beyond the seven presented herein. "Given that blockchain is a nascent and emerging technology, the present study is specifically focused on its application within the power plant industry. Consequently, this research can serve as a catalyst, motivating the exploration and adoption of blockchain technology in other industrial sectors."

9. Conclusion

Numerous studies, particularly within international literature, have explored the application of this highly beneficial technology in the supply chain. Accordingly, the present research is an endeavor to study blockchain platform to foster the application of the modern supply chain in contrast to its traditional counterpart. This research was carried out with the purpose of identifying the components of essential determinants of success for blockchain implementation in MAPNA Boiler and Equipment Engineering and Manufacturing Company. It focuses on the opportunities and impacts of these success factors, coupled with modern technology, to prepare the organization to confront the chaotic trend of challenges within the timespan of Industry 4.0 transformation In terms of its purpose, this research is applied, and its data collection methodology is descriptive. For data gathering, qualitative methods, including expert interviews and content analysis, were employed. In the quantitative phase, a questionnaire was administered to a statistical population comprising several experts in this field at MAPNA Boiler Company. According to the research conducted, the factors affecting blockchain were categorized into 41 components by the experts. Following their review, these components were grouped into 7 main categories. After categorizing and weighting each of the components, the following results were obtained:

1. Considering the obtained results, it is suggested that attention be paid to these components in the execution of supply chain projects, and their implementation should be ensured.
2. Given that some components have a higher priority and importance than others, the organization must consider their significance when allocating time and resources for the implementation of each factor.
3. Since Security, System Guidance and Control, Data Quality, Transparency, System Productivity, Speed, and Process Simplification are the 7 critical factors for blockchain success in the supply chain, it should be noted that:

- Security, as the most important component, pertains to standardizing information and records, processes, and the supply of goods for all individuals directly or indirectly involved in the system.
- System Guidance and Control, which includes information management, smart management, decentralization and integration, data recording, and the improvement of various contract types, is the second-ranked critical variable for blockchain success in the supply chain.

4. Quality also means quality assurance; it signifies goods and a supply chain free from any irregularities in process and transportation, reduction of raw material waste, elimination of human error, and the availability of complete information.
5. Transparency: Data is recorded and stored through the network and is visible and traceable throughout its lifecycle. This is introduced as another important factor in blockchain.
6. Expert interviews indicated that, in their view, decisive measures should be implemented to mitigate the likelihood of project failure through the provision of training programmes and the orientation of stakeholders regarding these critical components.

7. Since there are no specific standards for project success and the methods for measuring factors are highly diverse, this research can be used for similar projects and organizations.
8. By implementing these results in the organization, utilizing them in various process sections, and creating motivation for personnel, contractors, and specialists, the speed of achieving desirable and successful outcomes can be increased. Furthermore, by encouraging a positive approach to implementing these factors and using appropriate mechanisms for their deployment, effective steps can be taken towards preventing failure, sharing knowledge, and establishing knowledge management.

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