

BLOCKCHAIN FOR THE FUTURE OF SUSTAINABLE SUPPLY CHAIN MANAGEMENT IN INDUSTRY 4.0

Veena Prasad Vemuri, NKES College of Arts Commerce and Science, Mumbai, Maharashtra

Somanchi Hari Krishna, Vignana Bharathi Institute of Technology, Telangana

Chetan V Hiremath, Kirloskar Institute of Management, Karnataka

Dinesh Gupta, MIT World Peace University, Pune Maharashtra

ABSTRACT

This research aims to present an overview of Blockchain technology and Industry 4.0 with the purpose of promoting practices in Sustainable supply chains management. This study is primary and exploratory in nature. The sample size of the study was 250 employees working in oil industry as respondents residing in Pune, Maharashtra. The responses obtained from structured questionnaire. Confirmatory Factor Analysis is performed in the study. The variables under study were relationship management with suppliers, relationship management with customers, Just in Time, Long term planning, supplying management, subcontracting, electronic purchasing, logistics management and resource allocation. The conceptual model also framed. This study's findings reveal that SCM methods have a favorable and significant effect on the operational performance of the Pune, Maharashtra business sector. In spite of the fact that integration is unnecessary for many SCM methods, they may have a considerable effect on the operational effectiveness of particular Sustainable. By incorporating Blockchain technology into supply chain management (SCM) processes in real time, researchers can explore novel avenues for enhancing business effectiveness.

Keywords: Blockchain, Industry 4.0; Operational Performances; Practices; Supply chain.

INTRODUCTION

New companies can emerge because of the quickening pace of technology development, which is also increasing global competitiveness and decreasing company lifespans. Innovations in technology are influencing the necessity of new management strategies, which in turn is altering traditional forms of business organisations “Min, et al, (2019)”. Supply chains are entering a whole new competitive landscape as a result of this influence “Hussien, et al. (2019)”. Supply chain management's (SCM) primary goal is integration, and a higher degree of integration may improve operational performance by decreasing demand unpredictability, supplier inefficiency, and transition lags, and so lowering business environment uncertainty. Real-time information systems, which incorporate nearly all cutting-edge innovations, are the most effective method of integration, the IoT, Robotics, Big Data, AI, Industry 4.0, ICTs, and Blockchain to name a few Cai, & Zhu (2016)”. Despite many years of study, web-based information sharing was not successfully implemented due to security concerns “Fatima, (2021)”.

Despite this, there is a level of risk involved when using the Internet for sensitive data and monetary transactions; as a result, there has been a lot of focus on studying cyber-physical systems and cyber-security. Blockchain, a new technology, offers unparalleled protection against cyberattacks. The adoption of Blockchain into supply chains has been the subject of many discussions among scholars, but a comprehensive study has yet to be conducted “Hussien, et al. (2019)”. But the issue remains, do supply chains really need to incorporate ideas like Blockchain? The solution to this kind of inquiry is crucial to grasp. When dealing with supply chains, especially those on a smaller or medium scale, the cost of adopting and implementing a new technical concept to replace an established practice might be high “Ramchandra, et al. (2022)”. Additional factors that inhibit Blockchain's widespread

use in supply chain management include the unpredictability of the global economy and the lack of a clear regulatory structure, both for the smaller businesses that are hesitant to invest in Blockchain technology and for the larger ones that have already done so, mainly due to the absence of a standardized method for determining whether or not a given supply chain will benefit from the use of Blockchain technology “Agbo, et al. (2019)”.

Through this research, we present a paradigm for understanding the relationship between current SCM techniques and their effect on operational performance. In this study, we look into Blockchain's capabilities and compare them to supply chain management. It's possible for SCM procedures to vary from one supply chain to another, and even from one industry to another. Blockchain technology, which enables encrypted, in-the-moment data sharing, has recently gained notoriety as a promising new resource with which to improve business operations. Two factors led us to choose India's oil industry for this research and validation of the suggested framework. To begin, despite its obvious significance to the economy, this area has received comparatively little attention from academics. Also, the supply chain is extremely intricate.

REVIEW OF LITERATURE

The Blockchain records digital transactions in a decentralised and public ledger. This programme was created by Bitcoin, the first digital currency “Cai & Zhu (2016)”. Bitcoin transactions are conducted between untraceable individuals using cryptographically robust private keys “Brunese, et al. (2019)”. Every node in the network receives a copy of every transaction that occurs and is organised into blocks that are each given a hash that is used to uniquely identify each node. All network transactions are tracked by this sequence of blocks. “Fatima, (2021)” the term "Blockchain" used to be synonymous with Bitcoin, but in recent years it has expanded to encompass the underlying technology being used by other industries, because it has the potential to serve as a safe and reliable platform for exchanging data in real time, thereby fostering multifaceted and cross-sectoral integration “(Ghadge, et al. 2020)”. The commercial, judicial, financial, banking, healthcare, and instructional sectors are only some of the ones to have used blockchain technology. Blockchain technology has been used to create a digital distributed ledger for use in the logistics industry “(Chowdhury, et al., (2018))”. The same efficient, fast, and transparent benefits seen in the retail sector may be realized in the supply chain. Blockchain is being applied in a variety of settings due to its distinctive characteristics, which may be summed up as follows: real-time data exchange; internet safety; clarity; dependability; traceability; and discernibility.

These additions can facilitate a smoother evolution from antiquated to cutting-edge supply chain management “Kshetri, (2017)”. In complex supply chain networks, for instance, several vendors must coordinate their activities; as a result, they must use a central database to track and record all of their financial dealings related to the supply chain “Ojo, et al. (2018)”. As a result, a digital infrastructure that allows for the safe and instantaneous exchange of data is essential. Blockchain technology is one of the best ways to solve this issue. Many experts in the field have spoken out regarding the potential benefits and drawbacks of incorporating Blockchain technology into supply chains, as well as how the Blockchain itself would alter the nature of these networks “Srivastav, et al. (2019)” & made the observation that the performance of blockchains is considerably slower when compared to the performance of a typical or conventional based database. The cryptographic component of blockchain, which is widely regarded as one of the technology's most intriguing aspects, requires a significant amount of computational effort.

The Blockchain structure can be implemented into supply chains, according to one of the four proposed theories, which claims that the combination of these theories makes this possible. The resource-based view, principal-agent theory, the network theory, and the transaction-cost theory (also known as transaction-cost analysis) are all examples of these types of theories “Shi, et al. (2020)”. The resource-based perspective of the firm emphasizes the importance of a company's own resources and competencies as a source of competitive advantage. Potentially, blockchain could trigger processes with far-reaching effects on resources, capacities, and competitive advantages.

Information flows between principals and agents are described in detail by the principal-agent theory and agent gathers pertinent information from various sources

(suppliers, consumers, stakeholders, etc.) on principal's behalf “Srivastava, et al. (2016)”. Thus, it is necessary for principal and agent to set up means of mutual confidence and oversight. Through the use of blockchain technology, agency problems can be resolved thanks to the openness, accessibility, and verifiability of the data exchanged between principal and agent “Sahi, et al. (2017)”. The factors that are driving the adoption of Blockchain technology in India's service sectors have been identified. The factors that are driving the adoption of blockchain technology are going to be identified, and this will factor into the formulation of policies and decisions at multiple levels. In addition to this, the interpretive structural modelling (ISM) technique used to suggest hierarchical model structures. This paper can be seen as a step toward a more substantial theory building in adoption research, specifically of Blockchain technology in the Indian context.

Supply chain management, which coordinates the activities of numerous businesses in a market via a complex web of direct and indirect links, and network theory, which explains the roles and management of inter-organizational relationships, both deal with the complexities of networks “(Shahnaz, et al. 2019)”. With its transparent, real-time information sharing, traceability, and non-reputability of data during information transit, blockchain is a great tool for improving the quality of relationships between organizations, especially in complicated networks. Although similar to network theory, transaction-cost analysis emphasizes transactions rather than connection management. Organizational form and scale are key variables that are analyzed by TCA, which focuses on transaction costs “Chouhan (2020)”. In order to distinguish itself from competitors, a BPO will either implement new technology or apply existing technology in a novel way in order to improve a process. “Tariq, et al., (2020)” investigated the problems associated with the scalability of blockchain technology; the systems are critical to adjusting and enhancing the procedure. Aside from these, one of the most important concepts in the world of business right now is the use of cryptocurrencies like Bitcoin. The problems include the amount of time required to reach a consensus and the amount of time required to include a transaction in a block.

Research Gap

Blockchain's immutability creates a cyber-secure platform for transactions, fostering traceability and transparency throughout the supply chain's transportation and logistics operations. Despite the wealth of Blockchain-related writing over the past few years, no definitive methodology has emerged for determining whether or not a supply chain should incorporate Blockchain. Using the oil supply-chain in India (Pune, Maharashtra), this research is an initial attempt to fill this void in order to create a decision-making framework prior to incorporating Blockchain into the supply-chain.

Objectives of the Study

1. To identify factors influencing the future of blockchain technology in Practices of supply chain management in Industry 4.0.
2. To quantitatively assess the future of blockchain technology in Practices of supply chain management in Industry 4.0.

Null Hypothesis of the study

1. *H01: There is no significant relationship among the factors of blockchain technology and practices in supply chain management.*
2. *H02: There is no significant relationship among quantitatively assess the future of blockchain technology in Practices of supply chain management in Industry 4.0.*

Alternate Hypothesis

1. *Ha1: There is significant relationship among the factors of blockchain technology and practices in supply chain management.*
2. *Ha2: There is significant relationship among quantitatively assess the future of blockchain technology in Practices of supply chain management in Industry 4.0.*

RESEARCH METHODOLOGY

This study is primary and exploratory in nature. The sample size of the study was 250 employees working in oil industry as respondents residing in Pune, Maharashtra. The responses obtained from structured questionnaire. Confirmatory Factor Analysis is performed in the study. The variables under study were relationship management with suppliers, relationship management with customers, Just in Time, Long term planning, supplying management, subcontracting, electronic purchasing, logistics management and resource allocation. The conceptual model also framed (Figure 1).

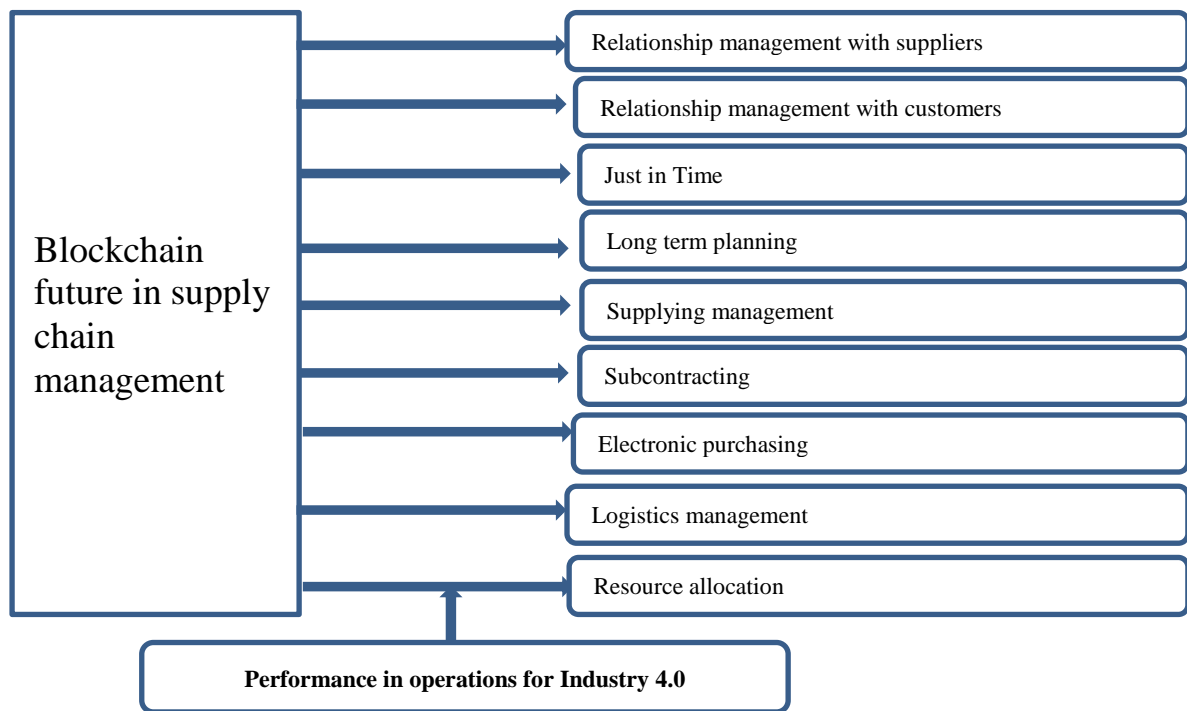


FIGURE 1
CONCEPTUAL FRAMEWORK

RESULT AND DISCUSSION

Table 1
CITY WISE DISTRIBUTION

City wise distribution	Frequency	Percentage
Delhi	50	20.00%
Noida	50	20.00%
Faridabad	50	20.00%
Gurugram	50	20.00%
Panipat	50	20.00%

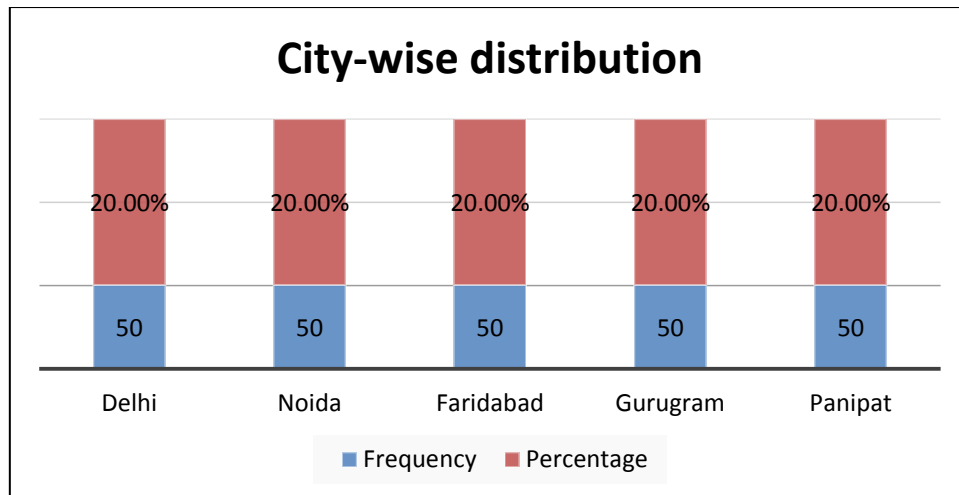


FIGURE 2
CONCEPTUAL FRAMEWORK FOR THE STUDY

City wise distribution is conducted in Table 1 and it was found that all the selected city participants were equally responsive and participative in the study Figures 2 & 3.

Table 2 AGE		
Age	Frequency	Percentage
18-25	60	24.00%
26-35	73	29.20%
36-45	43	17.20%
46-55	39	15.60%
Above 55	35	14.00%

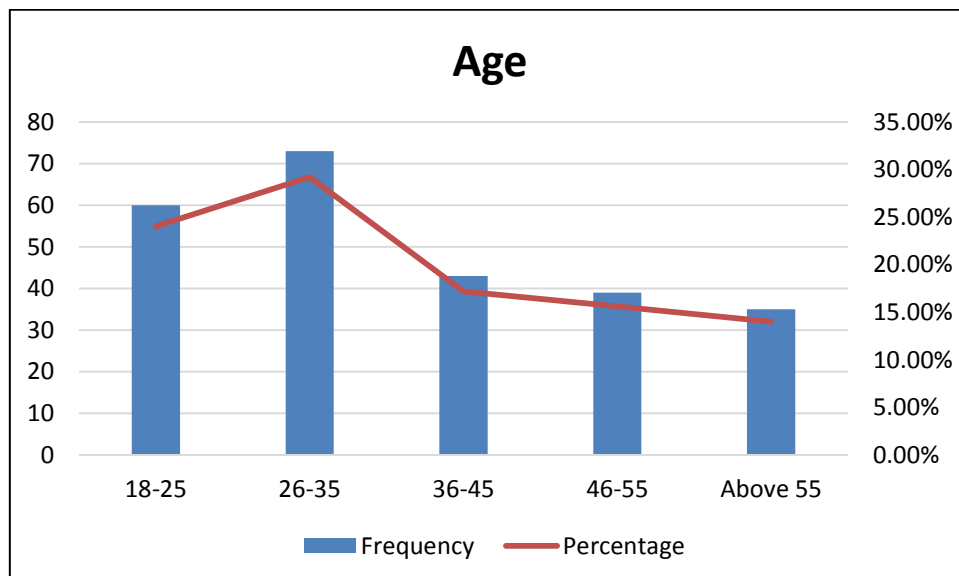


FIGURE 3
CITY WISE DISTRIBUTIONS

Table 2 stated the age wise distribution analysis and stated that majority of respondents having age of 26-35 years (N=73, 29.20%) followed by 18-25 years (N=60, 24%). The above

55 years (N=35, 14%) of age found to be least in the study Figure 4.

Table 3		
MARITAL STATUS		
Marital Status	Frequency	Percentage
Single	156	62.40%
Married	77	30.80%
Others	17	7%

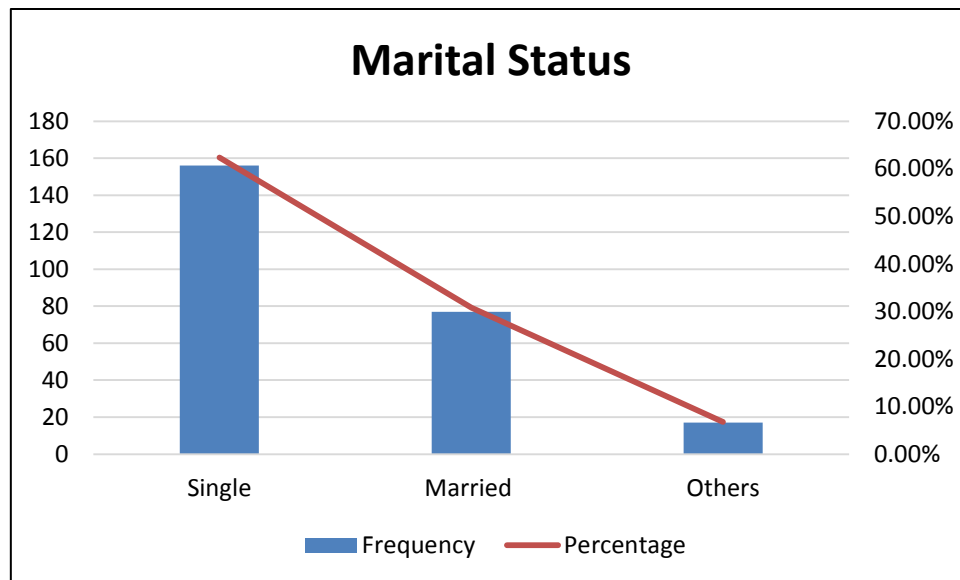


FIGURE 4
AGE WISE DISTRIBUTION

Table 3 depicted the marital status of the study and documented that majority of respondents found to be single (N=156, 62.40%) followed by Married (N=77, 30.80%). Others (N=17, 7%) found to be least in the study.

Table 4		
GENDER		
Gender	Frequency	Percentage
Male	215	86.00%
Female	35	14.00%

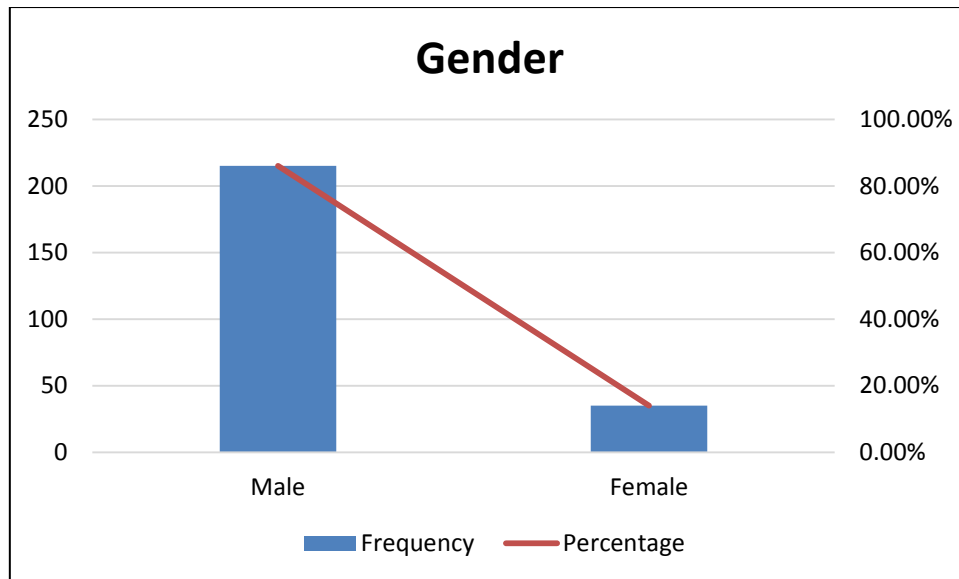


FIGURE 5
MARITAL STATUS WISE DISTRIBUTION

Table 4 depicted the gender analysis and documented that male (N= 215, 86%) are more participative in the study followed by female (N=35, 14%). Male are more responsive found in the existing research Figures 4 & 5.

Table 5 EDUCATIONAL QUALIFICATION		
Educational Qualification	Frequency	Percentage
10 th	55	22.00%
12 th	73	29.20%
Graduation	66	26.40%
Others	56	22.40%

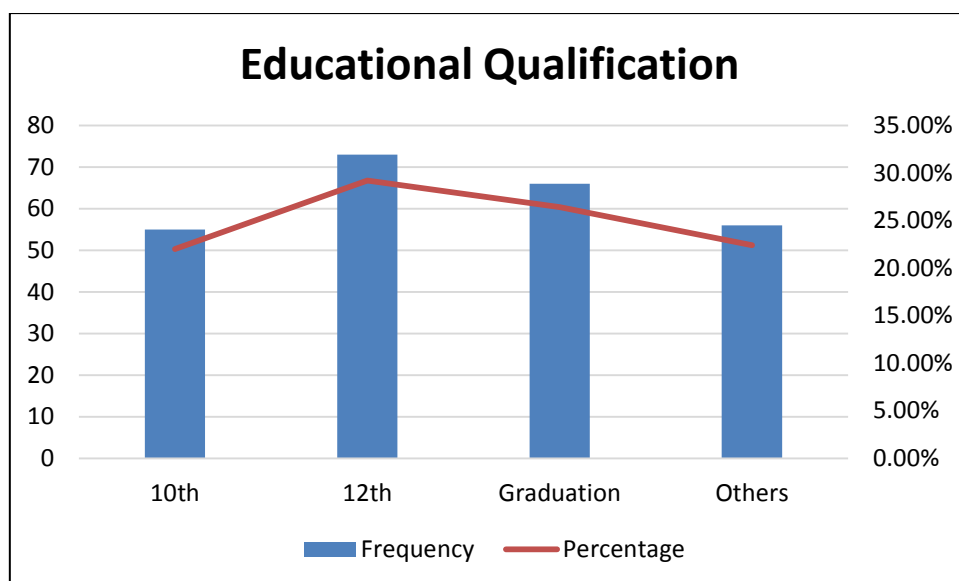


FIGURE 6
GENDER WISE DISTRIBUTION

Table 5 stated the educational qualification and found that majority of respondents having 12th (N= 73, 29.20%) pass out qualification followed by graduation (N=66, 26.40%) Figures 6 & 7.

Table 6 ANNUAL INCOME (RS.)		
Annual income (Rs.)	Frequency	Percentage
Up to 1,00,000	110	44.00%
1,00,001 - 2,00,000	62	24.80%
2,00,001 - 5,00,000	53	20.70%
Above 5,00,000	25	10%

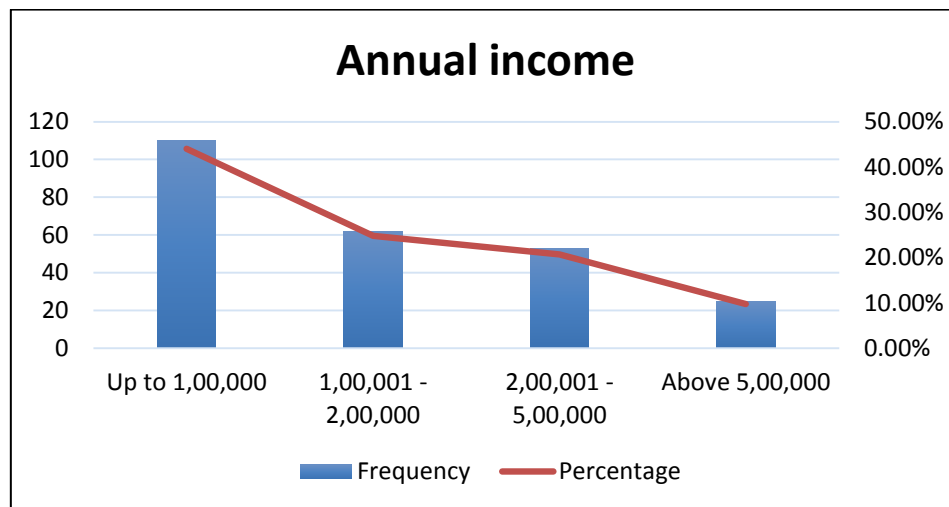


FIGURE 7
EDUCATIONAL QUALIFICATION WISE DISTRIBUTION

Table 6 documented the annual income of the study and found that majority of respondents' annual income was up to 100000 (N=110, 44%) followed by 100001-200000 (N=62, 24.80%). Above 500000 (N=25, 10%) found to be least in the study.

Table 7 DESCRIPTIVE STATISTICS					
Item	Variable	Mean	SD	1	2
1	Practices related to Supply chain management	3.577	.423	.634**	
2	Performance in operations	4.829	.367	.789**	

Table 7 documented the mean and standard deviation analysis and stated that Practices related to supply chain management having mean value 3.577 and standard deviation value .423. In case of performance in operations mean value is 4.829 and standard deviation value is .367. In case of correlation matrix estimated value is greater than 1.

Table 8 T TEST			
Relationship through path analysis	Estimated Coefficient value	Estimated value of T test	Permissible Value
Practices related to Supply chain management→ Performance in operations	.734	6.78	0.000

Table 8 analyzed the path analysis and documented that estimated coefficient value was .734 and estimated t value was 6.78. The permissible value was 0.000 which is less than the significance value of .005.

Table 9 HYPOTHESIS TESTING				
Relationship through path analysis	Estimated Coefficient value	Estimated value of T test	permissible Value	Decision
Relationship management with suppliers → Performance in operations	.645	4.888	.000	Accepted
Relationship management with customers → Performance in operations	.233	2.788	.000	Accepted
Just in time (JIT) → performance in operations	.324	3.234	.005	Accepted
Long term planning → Performance in operations	.356	3.568	.004	Accepted
Supplying Management → Performance in operations	.434	3.345	.001	Accepted
Subcontracting → Performance in operations	.532	3.567	.004	Accepted
Electronic Purchasing → Performance in operations	.323	3.234	.001	Accepted
Logistics Management → Performance in operations	.434	3.734	.000	Accepted
Resource allocation → Performance in operations	.234	3.112	.000	Accepted

Table 9 conducted the hypothesis testing and analyzed the relationship among the constructs and found that in all cases the permissible value was less than .005. Therefore, decision among all the constructs was accepted.

Table 10 RELIABILITY TEST			
Latent Variables	Observed items	Factor loading	Cronbach's Alpha
Practices related to Supply chain management	Relationship management with suppliers	.973	.813
	Relationship management with Customer	.543	
	Just-in-time (JIT)	.872	
	Long term Planning	.377	
	Supplying Management	.923	
	Subcontracting	.935	
	Electronic Purchasing	.978	
	Logistics Management	.234	
	Resource Allocation	.456	
Performance in operations	Lead time reduction	.807	.745
	Litheness	.567	
	Prognostication	.345	
	Saving cost and time	.789	
	Planning of resources	.445	
	Inventory Level reduction	.678	

Table 10 conducted the factor loading and analyzed the relationship among the constructs and found that in all cases the permissible value was more than 20%. Therefore,

decision among all the constructs was accepted. Moreover, in both cases the Cronbach Alpha value was greater than .60. Therefore, new formed constructs are having internal consistency among each other.

Findings

1. It was found that all the selected city participants were equally responsive and participative in the study.
2. The majority of respondents having age of 26-35 years (N=73, 29.20%).
3. The majority of respondents found to be single (N=156, 62.40%).
4. Male are more responsive found in the existing research.
5. The majority of respondents having 12th (N= 73, 29.20%) pass out qualification.
6. The majority of respondents' annual income was up to 100000 (N=110, 44%).
7. The relationship among the constructs found that in all cases the permissible value was less than .005. Therefore, all the variable understudy were positively correlated to each other.
8. The estimated value of Cronbach Alpha was greater than .60. Therefore, internal consistency among the variables were present.

CONCLUSION AND RECOMMENDATIONS

In order to boost operational performance, this study provided the foundation for incorporating Blockchain technology into supply chain management through SCM methods. This study's findings reveal that SCM methods have a favorable and significant effect on the operational performance of the Pune, Maharashtra business sector. This research also helps establish the connection between the many characteristics of Blockchains (such as near-instantaneous data exchange, Internet security, clarity, Safe money transfers, reliability, traceability, and discernibility and their respective benefits.) and practices in SCM (relationship management with suppliers, relationship management with customers, Just in Time, Long term planning, supplying management, subcontracting, electronic purchasing, logistics management and resource allocation)for improved cohesion. This research effectively proved that Blockchain is useful for improving supply-chain procedures and overall efficiency. The aforementioned tables provide a detailed analysis of both of the study's research questions. It is essential to realize that not all SCM approaches are integration based and that supply chains utilize a wide variety of SCM methods. Late differentiation and postponement are two examples of common SCM techniques. In spite of the fact that integration is unnecessary for many SCM methods, they may have a considerable effect on the operational effectiveness of particular supply chains. In addition, the lack of complexity in these supply chains due to factors such as a single source of supply, the absence of outsourcing, and the lack of customer/supplier partnerships suggests that the implementation of Blockchain may not have any noticeable effect on the SCM practices or operational performance. It's common knowledge that the price tag for adopting Blockchain technology is steep.

Therefore, the discussion suggests that the use of Blockchain is strongly suggested for supply chain networks that are both complicated and interwoven, like those found in the oil business. Managers and decision-makers can follow the path toward Blockchain implementation provided by the established connections between Blockchain capabilities and SCM procedures. The study's primary caveat is that it focuses on only one region of India (Pune, Maharashtra). Additionally, the developed association between Blockchain characteristics and SCM practises can only be supported by literature and cannot be explained empirically. A Blockchain can be a helpful tool in highly intricate supply chain networks. That's why industries with complex supply chains, like the oil industry or those that deal with its byproducts, need to adopt Blockchain technology. By incorporating Blockchain technology into supply chain management (SCM) processes in real time, researchers can explore novel avenues for enhancing business effectiveness.

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