A Study on Effectiveness of Blockchain Technology into Construction Supply Chain Management

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Abstract- In this present environment, the supply chain in the construction industry is facing many constraints like lack of coordination, communication, collaboration, and technology up-gradation, transparency, poor planning, and control. Supply chain management is very crucial while the products from one organization to another until it reaches the end-users or consumers without any damages, counterfeit, delay, etc. Consequently, the challenging issues in Supply Chain Management were distinguished by reviewing numerous works of literature. Empirical data models for the study were done through semi-structured discussions with experts. The target people of the study were essentially focused on the contractors, sub-contractors, and suppliers who were involved in construction projects. The separate proposals for contractors and suppliers were developed. The data grasped through discussions and distinguished from works of literature were examined by Descriptive statistics with the aid of Microsoft excels. This paper outlines the issues in supply chain management notably payment-related concerns in the construction industry and also the usage of smart contracts by blockchain technology in the supply chain. Also, the lack of data management in transactions leads to complications and for determining the reason for the disputes, So Blockchain technology is proficient in solving the issues addressed in the supply chain.

Keywords: Blockchain technology, Late payment, Smart contract, Supply chain management

I. INTRODUCTION

A. General

Supply Chain Management has been argued to increase productivity, reduce time, increase cash-flow efficiency and minimize risk [10] and also whenever the client requests a quality product and for more reliable services the adoption of changes should be easy. A Supply Chain (SC) can be defined as a network of members linked together by the flow of materials, information, and funds to reduce overall system cost [4]. The supply chain structure depends on the intermediaries and the participants in construction projects. In general, the facilities in the supply chain are supplier, manufacturer, distributor, wholesaler, and retailer. Modern firms operate in a rapidly changing complex environment [8] and increasingly depend on complex networks of supply chain partners to deliver goods and services in the accurate quantity at the right time and place under persistent cost and quality. SCM Method was applied in different areas, particularly in the manufacturing area, logistics, and many others. It is effectively helped several ventures to increase profits and from the several years in international markets. The successful SCM applications of Walmart, P&G, Ford, and Dell are the main examples of this SCM. As a result, they have become the leading companies in the market [4]. When the members are not coordinated, it may lead to poor performance of the entire SC. Coordination among members can be achieved by an information-sharing mechanism, and some of the objects in the sharing may include supplier's capacity, customer demand, inventory policies, and inventory levels of other members [4]. Many factors are leading to a project's success, especially concerning the payment system. Many shreds of evidence link project delay due to the inefficiency of the payment system. Payment default is considered a major problem in construction [1]. The recent developments in blockchain technology have led to the discovery of smart contracts as a creative method for the automated execution of contract conditions. A blockchain is a method of decentralized consensus that was proposed to record transactions across a peer-to-peer network of computers. Blockchain was originally introduced for Bitcoin (a decentralized digital currency, or also referred to as cryptocurrency), but then has evolved to other decentralized applications; such as smart contracts. A smart contract is a computerized protocol whose implementation is automated through an executable code that runs on the blockchain. Smart contracts have control over the physical or digital objects according to the agreed terms [2]. The smart contract payment method led to cost-effective and efficient possibilities for the security of payment.

B. Concept of Supply Chain Management

The supply chain has been defined as "the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer" [13]. Fig. 1 shows that information flow and the material flow of the supply chain in manufacturing site. The information flow started from the customers like by placing orders, scheduling etc. The information flow is from right to left where the material flow is from left to right.
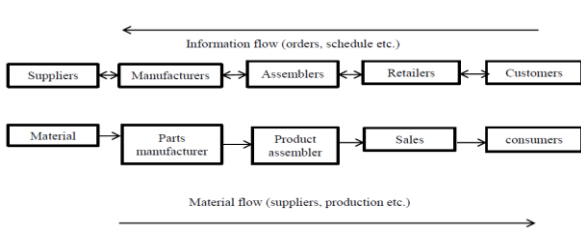
Fig. 1 Information and Material Flow of SC in Manufacturing [13]

C. Flow Chart of Supply Chain in Construction Industry

The general flow-chart of supply chain in the construction industries [3]. The Fig. 2 shows the flow of work from one part of the construction phases to other phases, like owners to architects and consultants which give the design.
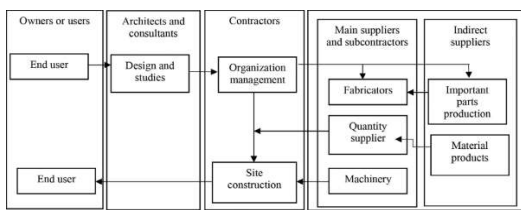

Fig. 2 Flow chart of SC in Construction Industry [3]

D. Reason for Payment Issues

Most of the suppliers and contractors encountering late payments. Since the article [6] reveals that 24% of suppliers invoices are paid late,

- 58% are due to long internal processes
- 57% are because the invoice was received late
- 25% are due to technology issues

This remains rare for suppliers to credit or expenses for late payments, 76 percent possess neither proposal to compensate suppliers toward late payments. Consequently, to evade late payment each purchase to pay cycle and order to cash cycle to be addressed and functioned fitly for the betterment into finance.

E. Procure to Pay

The purchase-to-pay cycle is a process related to purchase which is part of account payable. Reference [7] defines the purchase-to-pay cycle as follows: "The purchase-to-pay cycle is the trade cycle from the point of view of the company making a purchase. During the purchase-to-pay cycle, the company selects, receives and pays for the materials or other inputs needed in order for it to produce its goods or services". Fig. 3 shows the Purchase to Pay cycle steps involved in the process.

Fig. 3 Purchase to Pay cycle

F. Order to Cash

Reference [7] defines accounts receivables as follows: "Accounts receivables are created by a firm when it sells its outputs on credit". The order-to-cash cycle relates to a company's receivables. The order-to-cash cycle is the same cycle as the purchase-to-pay cycle, however, from a supplier's perspective. Reference [7] defines the order-to-cash cycle as follows: "It begins when a quote is prepared for a customer and ends when payment has been received and reconciled with the appropriate invoice". Fig. 4 shows the Order to Cash cycle steps involved in the process.
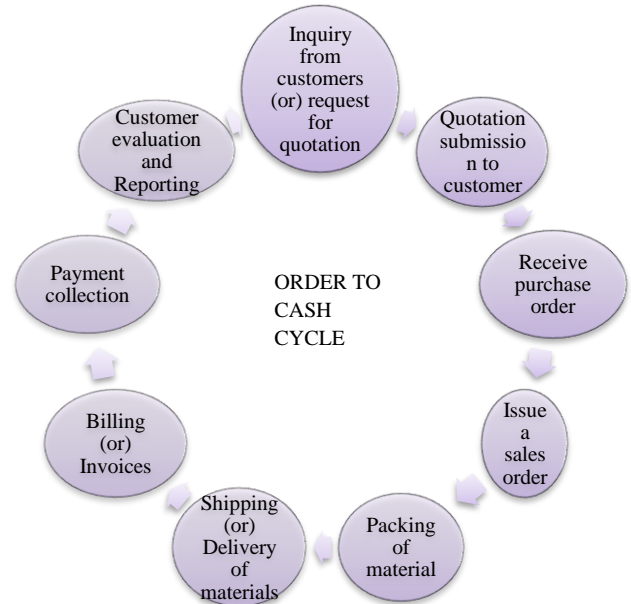

Fig. 4 Order to Cash cycle

G. What is Blockchain Technology?

Fundamentally, a Blockchain is a decentralized, distributed record, or 'ledger', of transactions in which the transactions are stored in a permanent and nearly inalterable way using cryptographic techniques [9]. Blockchain is an immutable, tamper-proof distributed ledger technology (DLT), which is utilized in a shared and synchronized environment where all the transactions are

validated by users and are traceable. It enables a decentralized environment where all the members of the network can interact securely without the need for a trusted authority. Hence it eliminates the need for a central entity by validating and storing all transactions through distributed consensus.

H. Smart Contract

Smart contract, which are automated computer programs that are triggered to transfer digital assets upon meeting certain trigger conditions, is the core technology used in the application of blockchain in the humanitarian aid field.

Corruption is a major problem in many third world countries, with multiple middlemen such as NGOs, local governments, etc. Smart contracts can help eliminate corruption by providing faster and less costly transactions with high transparency [11].

I. Blockchain Technology for Supply Chain Functions

SCM is an enormous sector and is the main skeleton of every industry. However, traditional SC systems are not versatile and transparent enough to accommodate the growing needs and demands of the future leading to huge overheads in terms of error handling, costs, administration and fraud management [11].

II.   LITERATURE

Venugopal Reddy Battula, et.al., (2020) [3], paper, gives an overview of desperate factors which inhibit the involvement of supply chain management for the business development in the construction industry. The questionnaire survey was framed, including past studies, also with the experts. A face-to-face interview was also conducted. In this study, more than 10 organizations are considered. Collected data''s are analyzed by the RII method and ranking of factors are done based on the mean value of RII. The findings of the paper result that contractors should provide the solution, for the improvement of supply chain management application in the construction industry.

Joby George, et.al., (2018) [4], this paper identifies various factors affecting supply chain performances. A detailed study is done by reviewing various works of literature for identifying the factors. Considering 54 works of literature the factors are identified. The major factors inventory control policy, information sharing, consumer demand, lead time. The appropriate selection of parameters of these factors improves the supply chain performance.

Kristofik, et.al., (2012) [7], this paper focused on collaboration with other parties within the chain. The author aimed to find the differences in Working Capital Management (WCM). In particular, collaboration and transfer of information between different departments managing each element of the supply chain is a key.

Manal Munir, et.al., (2020) [8], this paper is focused on the information processing view of risk management and

pinpoint the association between Supply Chain Integration (SCI) and Supply Chain Risk Management (SCRM) to improve operational performance. The paper synthesis the role played by Supply Chain Risk Management (SCRM) between Supply Chain Integration (SCI) and firms, operational performance is examined. The data is analyzed based on covariance for the developed hypothesis. The paper gives a framework demonstrating the effects of Supply Chain Integration (SCI) on Supply Chain Risk Management (SCRM), and the performance outcomes to develop managerial implications.

Omojola Samuel Oludare, et.al., (2018) [10], this paper states that supply chain management affects profitability and risk reductions. An as large number of participants involved in the delivery of projects is still complex. To address this, questionnaires were circulated to medium and large-sized firms. The data is analyzed using the Frequency Distribution and Relative Importance Index (RII). The finding shows that 42.6% of respondents rated lack of trust for suppliers which are discouraged by them.

Moulouki Reda, et.al., (2020) [11], this paper states the current practice of health supply chain. The study summarizes the benefits and challenges of blockchain technology. The paper focuses on healthcare supply chain with the application of blockchain technology in supply chain of healthcare.

III.   RESEARCH OBJECTIVES
- To identify the challenges and issues in the existing supply chain management.
- To study the effectiveness of Blockchain application for the supply chain issues in the organization.

IV.   RESEARCH METHODOLOGY

This paper aims to study the challenging issues in existing supply chain management in construction industries and to study the effectiveness of the application of Blockchain technology into Supply chain management. The data were collected through semi-structured interviews with experts. The data collected through interviews and identified from works of literature were validated and analyzed. The data will be instantiated in pie charts and bar charts.

V.   RESULTS AND DISCUSSIONS

The results from the interviews obtained from both suppliers and contractors are discussed below based on the objective of the study.
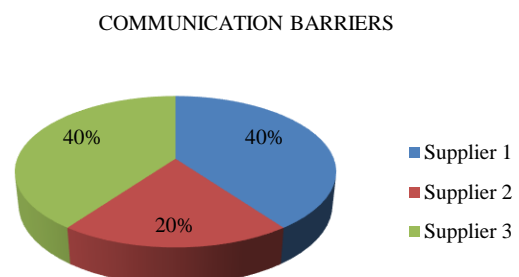
COMMUNICATION BARRIERS

Fig. 5 Communication Barriers Experienced by Suppliers

Fig. 5 shows whether communication was a barrier for the suppliers. About 40% of communication barrier was experienced by the supplier 1 and supplier 3 and 20% is experienced by supplier 2.

MATERIAL INFORMATION
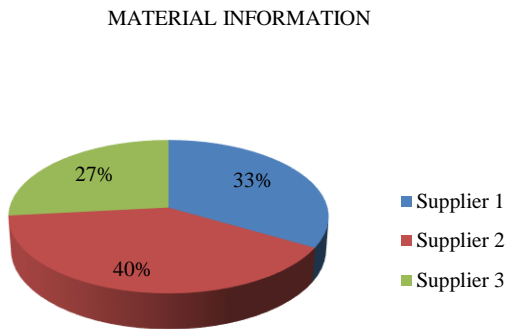

- Supplier 1
- Supplier 2
- Supplier 3

Fig. 6 Material Information Specified by Suppliers

Fig. 6 shows whether material information are specified by the suppliers. About 40% of material information was specified by the supplier 2 followed by 33% of information was specified by supplier 1. The 27% of material information was specified by supplier 3.
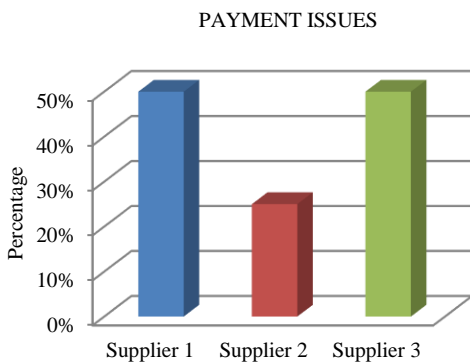
PAYMENT ISSUES

Fig. 7 Payment Issues Experienced by Suppliers

Fig. 7 shows the payment issues experienced by the suppliers. About 50% of payment issues were experienced by the supplier 1 and supplier 3. The supplier 2 experienced about 25% of payment issues in their company.

TRANSPORTATION ISSUES

- Supplier 1
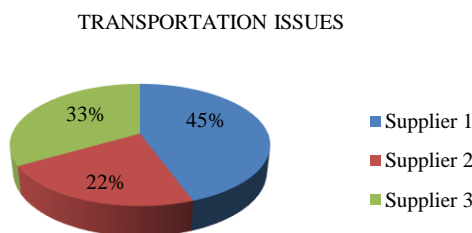- Supplier 2
- Supplier 3

Fig. 8 Transportation Issues Experienced by Suppliers

Fig. 8 shows the transportation issues experienced by the suppliers. About 40% of transportation issues was experienced by the supplier 1 followed by supplier 3 experienced 33% of transportation issues. The supplier 2 experienced 22% of transportation issues in the company.

SELECTION OF SUPPLIERS
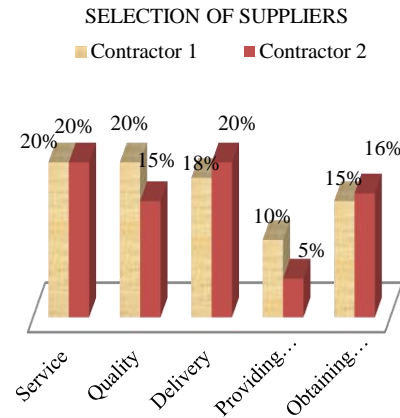

- Contractor 1
- Contractor 2

Fig. 9 Selection of Suppliers by Contractors

Fig. 9 shows the selection of suppliers by the contractors in the construction company. Based on service offered by the suppliers, about 20% were selected by both the contractors. About 20% and 15% were selected based on the quality of materials by the contractors respectively. Based on delivery 18% was selected by contractor 1 and 20% was selected by contractor 2. Followed by providing specifications and requesting a formal quote from suppliers, about 10% and 5% were selected by the contractor 1 and contractor 2 respectively. Based on financial stability 15% and 16% of suppliers were selected by the contractor 1 and contactor 2 respectively.
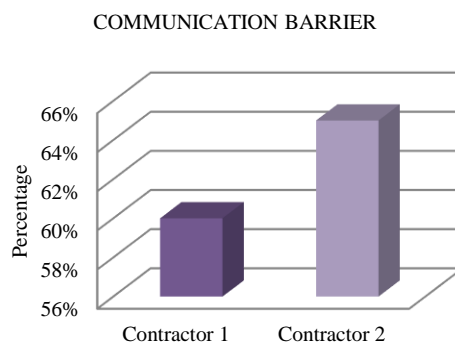
COMMUNICATION BARRIER

Fig. 10 Communication Barrier Experienced by Contractors

Fig. 10 shows whether communication was a barrier for the contractors. About 60% of communication barrier was experienced by the contractor 1 followed by 65% of communication barrier was experienced by the contractor 2.
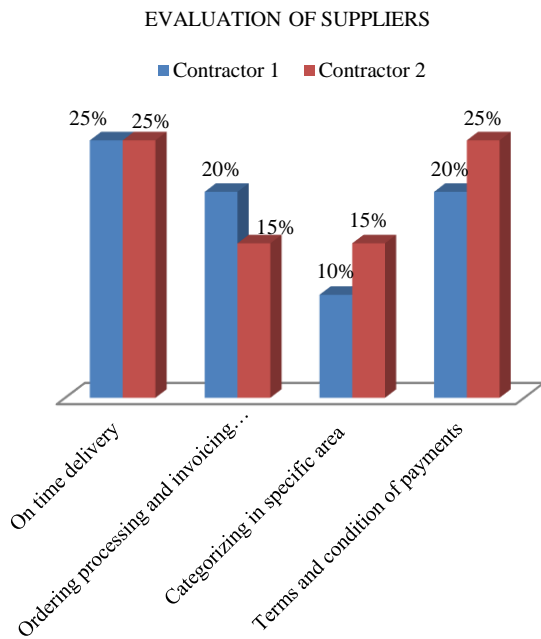
EVALUATION OF SUPPLIERS

Fig. 11 Evaluation of Suppliers by Contractors

Fig. 11 shows the evaluation of suppliers by the contractors. Based on timely delivery 25% of suppliers were selected by both the contractors. Then based on order processing and invoicing system of the supplier about 20% and 15% were selected by the contractor 1 and contractor 2 respectively. Based on categorization in specific area about 10% and 15% were selected by the contractor 1 and contractor 2 respectively. Based on terms and conditions about 20% of suppliers was selected by the contractor 1 followed by 25% of suppliers was selected by the contractor 2.
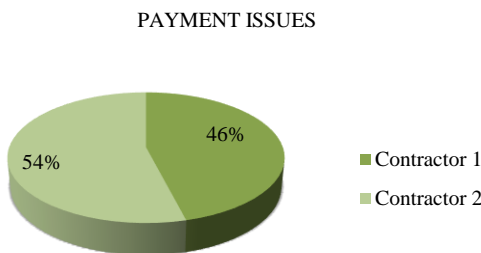
PAYMENT ISSUES

Fig. 12 Payment Issues Experienced by Contractors

Fig. 12 shows the payment issues experienced by the contractors. About 46% of payment issues was experienced by the contractor 1 and 54% of payment issues was experienced by the contractor 2.
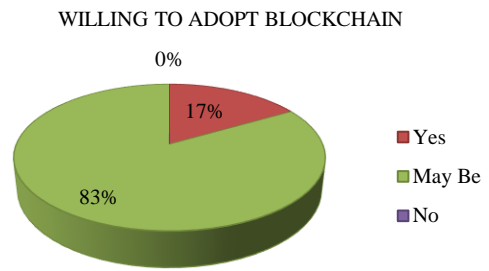
WILLING TO ADOPT BLOCKCHAIN

Fig. 13 Willingness to Adopt Blockchain by Suppliers and Contractors

Fig. 13 shows the suppliers and contractors willingness for adopting Blockchain technology for the betterment of supply chain management.

A. *Inference from the Discussions with Suppliers and Contractors*

▪ It is inferred from discussions with suppliers and contractors that both of them undergoing communication issues because there is no proper management.

▪ More than 50 percent of suppliers encountering payment-related issues that influencing the bond with the buyers to have a prolonged relation.

▪ Contractors were choosing the suppliers based on service offered, quality of material distributed, and also on-time delivery without any delay.

▪ So, the problems identified like communication barrier, payment, and also transportation will provide advancement if Blockchain technology were integrated into the Supply chain mainly smart contract via Blockchain contributes an improvement in payment associated issues.

▪ Blockchain technology working concept also via smart contract and its benefits and challenges were addressed below.

Supply Chain Management of construction industries may improve by updating into new technology such as Blockchain Technology for better management. As Blockchain have better visibility, trustworthy, unalterable, transparency and also enabling enchanced data sharing.

B. *Blockchain Technology*

In the simplest terms, a Blockchain consists of a linked chain that stores auditable data in units called blocks. Each block contains data (anything of value), its own hash value (a unique cryptographic value containing characters and numbers generated through a complex computational algorithm) and a pointer to the hash of the previous block [12]. Figure 14 shows a blockchain developed after the transaction.
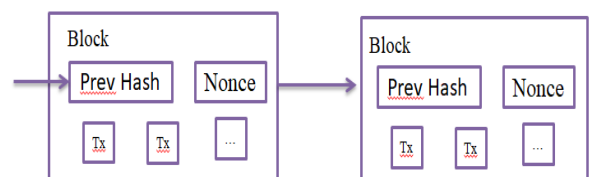

Fig. 14 A blockchain

C. Types of blockchain

Three major types of blockchain networks, each having their own characteristics are consortium blockchain, private blockchain and public blockchain [12].

Consortium: A consortium formed by a group of members control this blockchain. Verifying and adding records to the blockchain is based on a consensus mechanism by a pre-selected set of nodes.

Example: In regulatory related decision-making.

Private: This is controlled by a centralized entity. Only people with specific authentication and permission can be part of this network and thereby can verify and add records to the blockchain. However, the blockchain could be publically viewable. Participants in this blockchain know and trust each other. Also known as a permissioned ledger.

Example: A permissioned ledger between banks to settle inter-bank fund transfers and supply chain with well-defined roles for all actors.

Public: Public or permissionless blockchain are decentralized and are visible to the public, anyone can join or leave the blockchain and anyone can verify and append transactions to the blockchain. This type of blockchain facilitates the dynamic collection of participants who may not know each other. Hence, stringent consensus mechanisms have to be implemented in this system.

Examples: Time stamping, trading of renewable energy.

D. How it works?

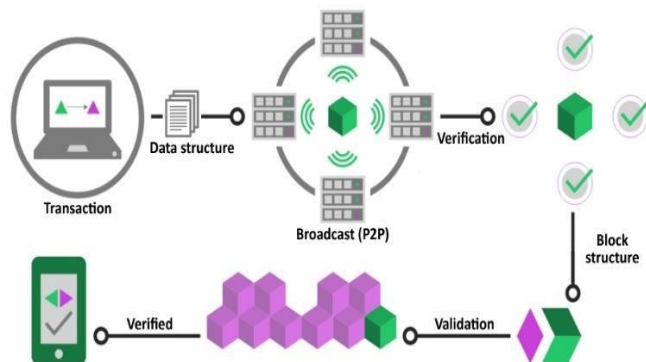Fig. 15 shows how the blockchain technology works when a transaction is requested [5].

Fig. 15 Blockchain structure-overview [5]

E. Smart contracts

Smart contracts are self-executing agreements that are triggered on the basis of predefined and agreed events. The "smart" in a smart contract comes from the fact that the clauses in the contract are evaluated and the appropriate code executed without human intervention. Settlements in smart contracts are automatically triggered if the pre-agreed conditions coded into the contract are met. Imagine something along the lines of the automatic debit used by merchants to take payment from your bank account, based on pre-agreed conditions (full payment, part payment, minimum amount etc.) on a pre-agreed day or date [12].

F. Benefits of Blockchain in Supply Chain

- Authorizes calibration of data determined over distinct Supply chains.
- Enhances protection of data saved.
- Substantial time capturing of every piece of information had been performed.
- Customized and unique contracts can be determined toward all duties moreover can be organized by each other.
- Betters visibility and excludes the need for an intermediary.
- Helps follow the status of an object throughout a process.
- Automates data examination activities.
- End to end clearness based on trust level by authority.
- Develops end-to-end activity of the Supply chain method.
- Recognizes flaws plus problems, in the commencement, to obtain the process robustly.
- Points to a continuous chain of transactions.
- Boosts speed.
- Gains trust with stakeholders of the process.
- Consensus mechanism toward every alteration.
- Assures assurance of each transaction.

G. Challenges in Implementation of Blockchain in Supply Chain

- Satisfying any stakeholders to share information remains a difficulty. Organization's extensive technology transformation and selection were expensive also time-consuming.
- Privacy and protection of data want to be assured as the technology is yet quite immature and helpless.
- Governing change can affect many undesired complexities.
- Blockchain should be employed selectively later scaling in the finance of implementation in phases of both expense and uncertainty.
- Huge numbers of stakeholders were included and altering age-old mindsets, knowledge, and practicing method were a prominent problem.
- Intermediators connected at different levels might be reduced which can perform rifts.
- A thought that blockchain implementation might head to loss of careers.

VI. CONCLUSION

The study investigates the challenging issues which inhibit the improvement of supply chain management. The objective of the study was to identify the challenging issues in the implementation of supply chain management and to study the application of Blockchain technology for enhancing the supply chain management in the construction industry especially for payment issues using the smart contract. We can understand that the supply chain affects profitability and project expectations in terms of cost, time, and quality, and risk reduction. The study provided new insights into the construction industry, how the blockchain will change existing concepts of Supply chain management. The blockchain was introduced to achieve the supply chain objectives, by reducing the risk from tracking and data management and recording of transactions. Blockchain facilitates valid and significant measurement of outcomes and performance of key supply chain processes. The study explores how blockchain may

transform the supply chain in the future. Overall, blockchain technology as an application to supply chain management shows promise.

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