

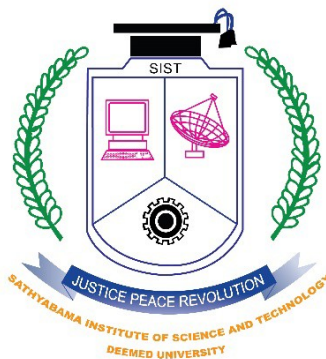
CONTRACT MANAGEMENT FOR PROCUREMENT AND SUPPLY CHAIN USING BLOCKCHAIN AND SMART CONTRACTS

A Thesis

Submitted in partial fulfillment of the requirements for the award of
Master of Architecture degree in Building Management

by

Lokhesh S (39840012)



**DEPARTMENT OF ARCHITECTURE
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited with Grade “A” by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119.

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BONAFIDE CERTIFICATE

This is to certify that this Report is the bonafide work of **Lokhesh S (39840012)** who carried out the Thesis entitled “**Contract Management for Procurement and Supply-Chain using Blockchain and Smart contracts**” under our supervision from January 2021 to May 2021.

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ABSTRACT

One of the most fragmented high impact industries in the world is the construction industry. Comprehensive commitment and resources is needed to address the problems, to keep track of work, schedules, costs and payments. Building projects face a variety of flaws, faults, and wounds at varying levels and levels as well as these difficulties. The contract outlines what all parties commit on and who is responsible for the arrangements if matters do not go as planned and these clauses describe how all these project risks, ultimately known as contract management, are distributed and handled.

The building industry usually uses paper contracts, though. They are useful, but limited when they are altered, checked or stored, and what happens when a paper contract has been robbed or accidentally lost? Technology enters this region. In digitizing paper contracts, the building industry is now more pragmatic. Contract processing techniques are Blockchain's new century. The digitalization of paper agreements on the blockchain will revolutionize the preparation, transaction, stocking, and compilation of contracts. In this thesis, we have analyzed how blockchain and smart contracts could have been used to managed construction contracts especially in the areas of procurement and supply chain and how they could have been used to avoid 3rd party involvement, increase transparency, reduce costed and time overruns for all the stakeholders of the project. Finally, this procedure was compared with the current conventional way of managing contracts and then the results were validated.

KEYWORDS:

Contract Management; Blockchain; Smart Contracts; Procurement; Supply Chain; Digitization; Secure; Transparency; Traceability; Encryption.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

In recent years, technological advances have evolved at an almost unfolding pace. Artificial intelligence, robotics, cloud computing and the Internet are only a few manifestations of how we are living and running. There are still no clear indications of further changes in the economic and social economy, but one thing is certain: anyone who can use these technological advances in their business model can quickly adapt and gain a market edge in the sector and provide better services for both customers and users.

Another application of this kind is Blockchain. Many consultants have recognised the capacity of transforming industries, market structures and operating processes, such as bill arbitration, payroll, administration, supply chain, relationships with customers, finance... Discussion began to identify the most critical areas (industries, operating systems, etc.). Prominent Blockchain technology candidates may add value, enhance transparency and efficiency.

Trust is one of the most critical and perhaps most precious resource of almost any organisation. Inside the organisation, the Board members and the staffs are at several stages. Yet the agreement between the company and their suppliers and their customers remains an important part of every kind.

This confidence has been permitted as a general policy by third parties and intermediaries who have ensured competence, accountability and openness in the contracting parties. The trust and transparency of third parties is so hard, details were often shrouded in depth and sometimes time intensive and costly. Blockchain is one of these kinds of applications as it ensures that the information is delivered transparently to board members so that no individual has the sole leverage over the results. The data are divided into an unchangeable and almost unchangeable detail at a predefined time. In addition, all transmitted Blockchain data are eternal.

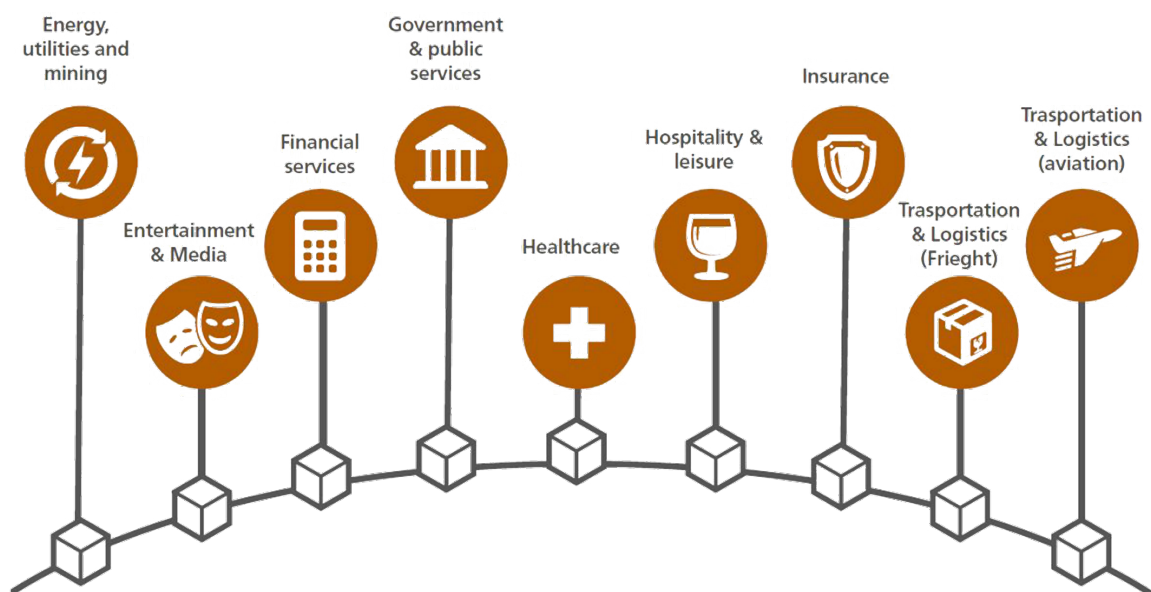


Fig 1.1 Industry use cases

1.2 WHAT IS BLOCKCHAIN?

1.2.1 Overview

Blockchain is a distributed DLT technology which, due to the underlying technology of Bitcoin, was initially launched almost ten years ago. We first ought to know whether the ledger is distributed to understand this?

A distributed directory is a simple but featured folder. Which means that the database is dispersed in many places. It is distributed. It is also equivalent to a conventional cloud system or other popular stores on the Internet. However, instead of only one source with various accesses, several stores (like ledgers) are spread that are modified concurrently. A distributed directory is often a network where any user can chat or connect peer-to-peer. An extremely resilient network protocol or a consensus function of the DLT makes this clear sharing of information between the interactive parties possible without any intermediary. These interactions are then encrypted and added to the immutable record chain, and in the case of a Blockchain framework.

Consider, for example, a scheme where there is a system that holds several records for every entity, rather than making one central accounting directory with all transactions between contracting parties (a) (b). Instead, the Blockchain is managed by the network and its protocol, only one source or a single source of information (immutable transaction data, interactions) is copied and exchanged for those communicating over the network, or the Blockchain.

The encryption includes certain transfers within the blocks. In addition, since each block of the Blockchain includes elements/information of the previous chain blocks, a particularly durable, trustworthy record is created. If you want to change one block you must change the entire chain without manipulating the rest of the network. It is impossible to change the whole chain.

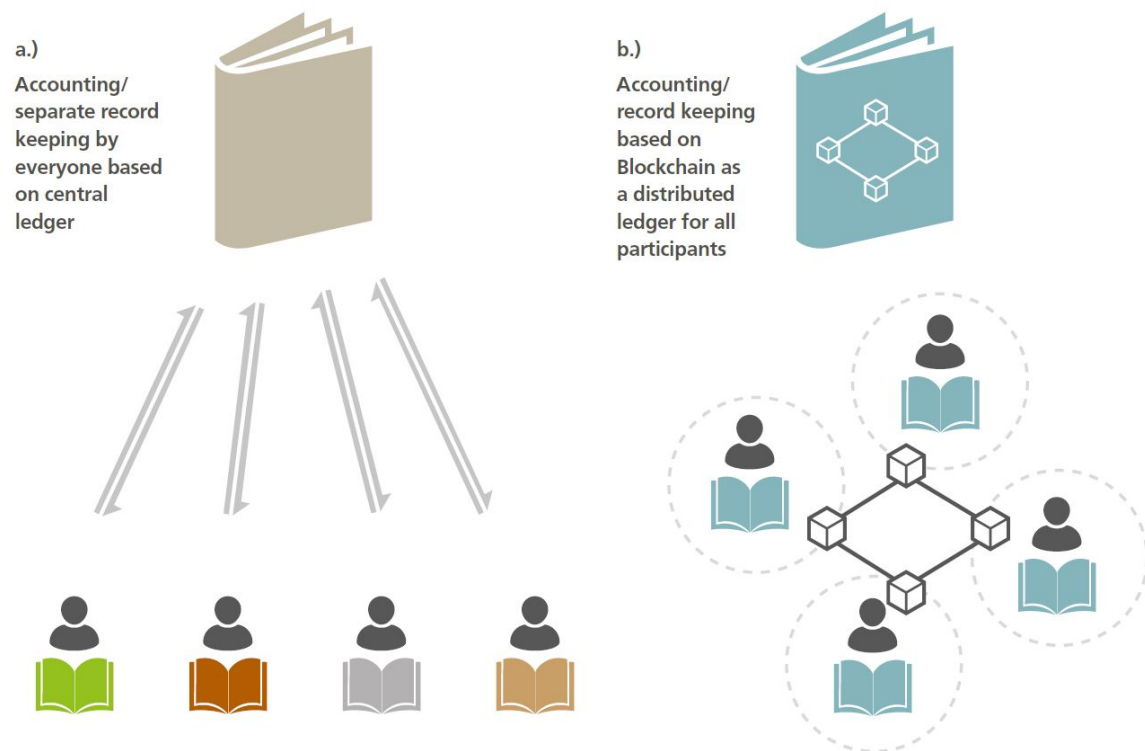


Fig 1.2 Centralized (a) and distributed (Blockchain) record keeping (b)

1.2.2 Why Blockchain is important for the construction industry?

There are potential Blockchain technologies already in place and have an economic effect. Some may apply exclusively to the manufacturing industry, and some may be of benefit to the building sector.



Fig 1.3 Blockchain-enabled features for the construction industry

Blockchain consists of three main industries where it is applied in the c industry

- Payment and Project Management
- Management of the sourcing and supply chain
- Asset Management and BIM.

The first part defines a simpler way to start payments and to manage building programmes. Second, we will explore how Blockchain will bring a new traceability layer by maintaining the meaning and transparency of project acquisitions in its permanent record. Finally, Blockchain and BIM are discussing their connection and possibilities to unleash the industry's long-awaited fruitful relationship.

1.2.3 Public and Private Blockchain types

These functions are used mostly in two kinds of blockchain systems: public blockchain, which can be participated by anyone on the network, and in private or approved networks that identify and indicate users.

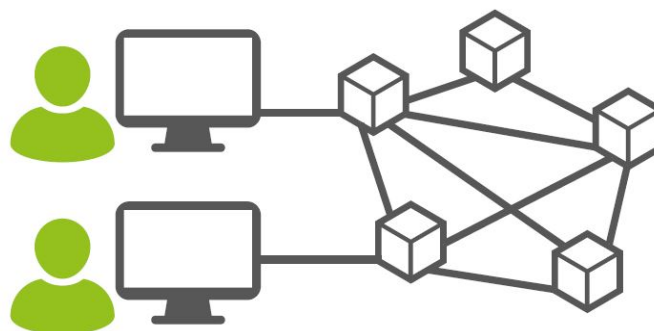


Fig 1.4 Public Blockchain

- Anyone will enter and work together
- All purchases shall be public and anonymous
- Transaction fee is due
- Relatively poor networking
- Extremely immune to hacking
- Hard to incorporate improvements to the framework

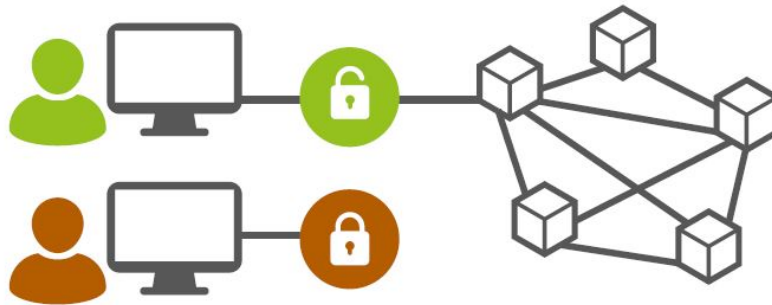


Fig 1.5 Private Blockchain

- Only established representatives will join and negotiate
- Transactions are both public and private
- Transaction charge can be reduced
- Quick networking
- Resilient for hacks
- Simple to incorporate improvements to framework

The key difference is that the network management and verification of transfers must be promote to public network customers. As an example for the Bitcoin Blockchain, each node is competing to check and add new transactions to the Blockchain. They do so as the node that implemented the new block is rewarded with new bitcoins as well as transaction fees until each new block is done and streamed into the net.

Since the network is public, everyone can also be a part of it, there is also an extensive degree of decentralisation which makes the network extremely vulnerable to hacking.

Conversely, a more formal solution is provided by the accepted network such that network management is directed by network members. Network participants developed and validated. This reduces the drive as people are encouraged to retain the network. And dependent on their business partnership they run.

For example, the client and the contractor, in the construction project, initial priorities were different for both of the contracts, such that the operation of the transaction confirmations as network nodes would both have been permitted. None of them would therefore be willing to encourage the other person to do something wrong.

1.2.4 Smart contracts on the Blockchain to enhance efficiency

Blockchain technology, the so-called smart contract, was brought to life by a major breakthrough. Especially if the predefined conditions are fulfilled, it is a digital contract that will automatically perform the terms and conditions. Smart contracts are one of Blockchain technology's most exciting prospects since they will use various mechanisms to be improved, streamlined and eventually more efficient.

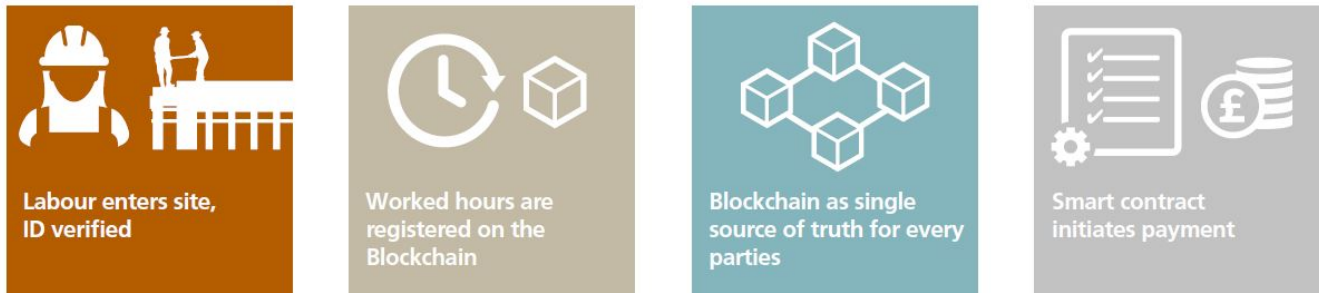


Fig 1.6 Smart contract governed site working hours register and payment system

Any employee enters the building for security, health and security reasons, changes his ID card at the premises. Information is compiled on who has entered and how much time they have spent working on the site and is recorded on a public Blockchain register between the client, the seller and the contractor. This requires no further management to validate this data, as it was already signed into the Blockchain. The smart contract can trigger payment and, if applicable, present payment certifications to all the parties based on agreed terms on the amount of days spent on site.

In this way, the parties do not request back and forth to compare the hours recorded in their respective directories. It was also accomplished on the basis of a unified reality Blockchain-enabled source, repeated and updated for each participating organisation.

This is a simple example, but the advantages of a Blockchain structure are obvious. It can be extended so that payments, submissions and proposal updates are executed automatically and the overall process is made more effective.

This means that all data and information recorded (e.g. number of hours) and initiated transactions (e.g. refunds, updates for projects sent) are also signed in to the Blockchain and make the whole process clear and traceable. If a discrepancy, like a clause included in a smart contract with the agreement of all the parties involved, merely initiates a reverse transaction. The main advantage for industry participants is that these messages are both tamper-resistant and straight-forward.

An important characteristic of such a smart contract-enabled mechanism is that other parties or sources of evidence still have to be included. These allies, also called oracles, retain the connection between the smart contract and the mechanism they deal with.

1.2.5 Sensors and collaborators on-site informing smart contract

Construction site sensors track temperatures and then verify which data are tested from different websites with weather data from that particular part of the area. These figures are measured periodically using a smart contract, which automatically initiates negotiated activities and award events when certain conditions, such as too high or too low temperatures are triggered. Additional sensors can send structural element locations during construction or RFID data from material arrived to update the project plans and track progress. Other sensors may send structural items in the GPS area. Another sensor array on the crane can modify its operating status and leasing requirements that are automatically handled by a smart contract.

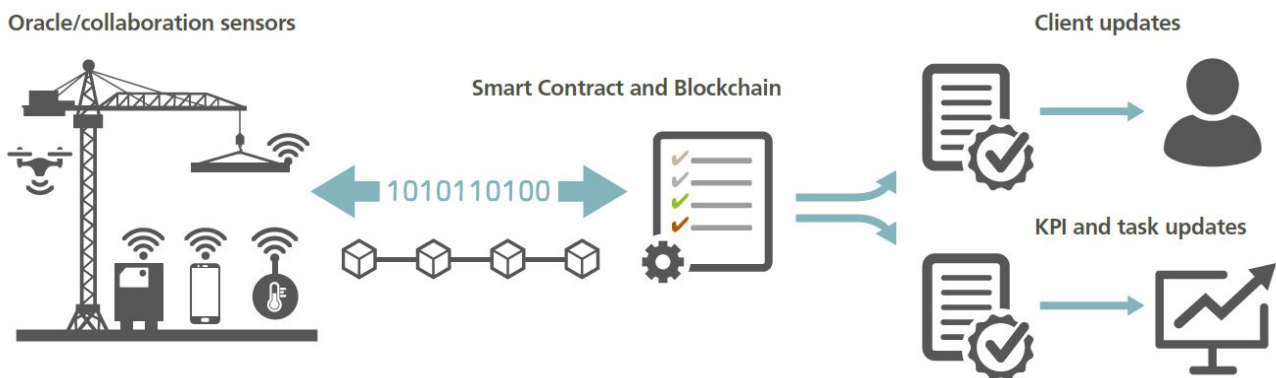


Fig 1.7 Sensors and collaborators on-site informing smart contract

1.2.6 Benefits of using smart contracts in the construction industry

- **Accuracy** - If the terms and conditions of the contract are accurately documented on a smart contract, the execution and control of the terms and conditions are very reliable.
- **Transparency** - Each invoice, contract, business interaction, and execution can be recorded on the Blockchain, rendering the entire process transparent and followable.
- **Cost-effectiveness** - Substantial cost reductions will be achieved on overheads, management, and project management. Besides, project management knowledge is logged in a traceable manner to unlock project evaluation and cost optimization insights.
- **Risk management** - The Smart Contracts Network will ensure accountability and decreased uncertainty for the whole building contract. In this way, the probability of late payment and the number of conflicts can be minimized.

1.2.7 Stages of Blockchain Implementation for a business

Before the implementation process begins, companies must examine their current procedures carefully and pose the correct questions, such as whether they require a blockchain solution.

The first step is to establish its applicability when the right business situation is identified for a blockchain solution. In order to do so, the organisation has to identify a feasibility study on future return on investments.

What is the investment return (ROI), who are the founders, the main success metrics (KPI), and what are their issues with the existing frameworks??



Fig 1.8 Stages to move towards the implementation of a blockchain solution

ROI not only entails financial benefit; it can also entail decreased volatility, thus reducing risk and enhancing cooperation with trust. It is important to find out who the project participants will be early and what their main performance measures are in order to measure how effective the new system is.

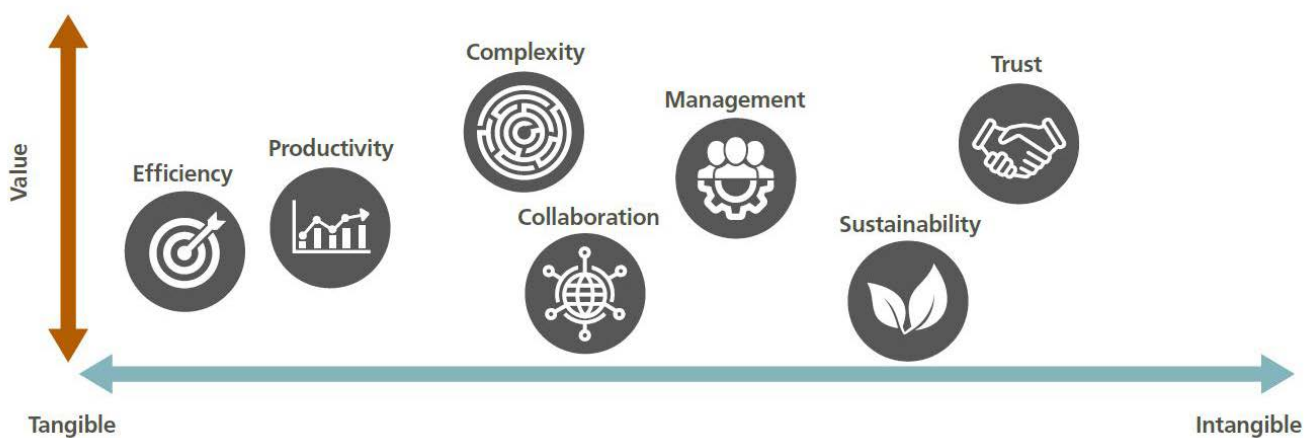


Fig 1.9 The different ROI angles of a blockchain solution

1.2.8 Criteria for evaluation and adoption

Blockchain is a game-changing technology but achieving return on investment demands a tight regard to the technology's appropriateness for the supply chain profile of the enterprise, as well as the predictability of returns on investment. The following five characteristics will help influence your time and value decision for blockchain prototyping. If an idea has been settled, the prototype on a testing network with stupid data will be first validated externally until the blockchain is piloted before investment is made.

Table 1.1 Adoption Considerations

Traceability Needs Whether or not blockchain prototyping makes sense depends on the supply chain's traceability requirements.	Key Questions: - What is the need for traceability? - Who will be in charge of entering data? - Who will require data access? - What information must be kept private?
Material Characteristics and Production Profile Blockchain and the data contained on it are only accessible in the digital world. Other technologies are necessary to link the data tracked in the blocks to the actual goods being tracked. Blockchain developers are playing with technology such as the Internet of Things (IoT) and smart sensors. Their application is determined by the properties of the products being monitored.	Key Questions: - What are the physical substance being tracked, its size, and shape? - What technologies are available to connect physical materials to their digital counterparts? - How are the materials tracked during the manufacturing process? - Is the code used to bind physical materials to the blockchain tamper-proof?
Supply Chain Layers and Partners Obtaining an agreement to incorporate blockchain in supply chains of several layers and more partners necessitates a substantial rise of stakeholder involvement. The risk, viability, and benefit of using blockchain are determined by the benefits and transparency of sharing between the participants. Where there is a lack of a centralized trust entity, blockchain can be an efficient solution.	Key Questions: - How many levels of production or supply chain are involved in the process? - Do you work in a field where your supply chain partners would be able to follow your lead or cooperate with you on this? - Do you and your associates want a central trust agency? - Is there a danger that several device collaborators will conspire to alter the records?
Technology Environment Implementing blockchain necessitates a shift in each party's data record structures to a centralized common data framework.	Key Questions: - What is the commitment required to link to your company's and your partners' existing networks and data structures? - How can you switch from the present data structure to the blockchain data framework? - In the geographies do goods move during the supply chain, and is it simple to connect a technology gateway to the Internet in these environments? - What changes to the existing systems and data structures are required?

Table 1.2 Current limitations and potential risks

Integration Concerns Blockchain implementations necessitate major modifications to, or total redesign of, existing structures.	Potential mitigation Create a long-term strategy to define framework change conditions for blockchain adoption.
Linking digital to physical RFID, 2D barcodes, and near field connectivity are all examples of radiofrequency identification (RFID). (NFC) are now used to link to physical devices. The item, However, to maintain the flow of data, all phases of the supply chain and all materials would be required to be labelled digitally, which necessitates a redesign of today's world Supply chain procedures	Potential mitigation Begin strategizing now for how to physically track objects and incorporate automated labelling into current supply chains to plan for blockchain adoption.
Control, Security, and Privacy Although technologies such as private or permissioned blockchain and strong encryption are available, there are still cybersecurity issues that must be resolved until the general public can entrust confidential data to a blockchain solution.	Potential mitigation Choose a blockchain solution partner wisely, cooperate to ensure protection and privacy standards are fulfilled, and thoroughly verify before piloting.
Cultural Adoption Blockchain marks a major transition to a shared network, which necessitates customer and provider buy-in.	Potential mitigation To reduce unnecessary costs or deployment risk, socialize the concept of implementing blockchain in your business and partner with stakeholders before implementation.

1.3 PROCUREMENT AND SUPPLY CHAIN MANAGEMENT

1.3.1 Transparency based supply chain including material provenance

The possibilities for Blockchain systems don't stop with payment. The current supply chain management of the construction sector will also revolutionise, ensuring provenance for concrete materials and the establishment of a regulated custody chain available to all supply chain stakeholders.

Today, suppliers, manufacturers and providers of the materials used in construction projects are also more knowledgeable for reasons such as strict compliance with durability, protection and health, material requirements and sustainability. The system is therefore not free from defects and negligence.

Imagine a Blockchain platform that logs and traces the supply chain down to the construction site specific building features such as prefabricated concrete and steel elements. The advantages are relevant in all project partners, such as a buyer or project manager, and before shipment to the website, all the information on the items received such as the certificates of manufacture and condition and the transport path are made available. At some point of the supply chain in this enduring custody chain,

Stakeholders should have confidence in product coherence, safety conditions and practises. In addition, it is easier, quicker and less administrative to monitor any activity within a supply chain (e.g. manufacturing time, freight forwarders and scheduled arrivals along with freight certificates).

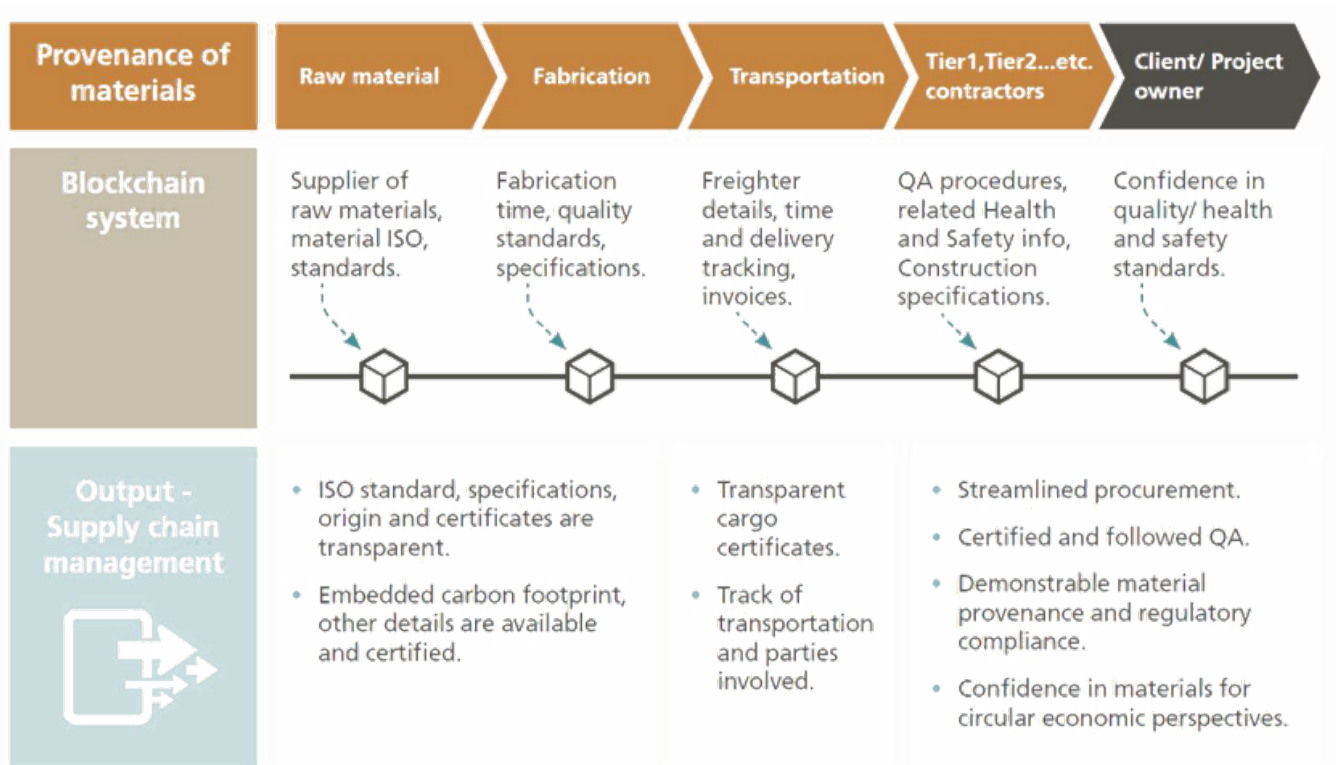


Fig 1.10 Transparency based supply chain including material provenance

1.3.2 Sustainable procurement in the construction industry enabled by Blockchain

The improvement of the sector's fractured procurement processes and the introduction of the roots, sustainability, are another key aspect of the entire supply chain.

Tata Steel has produced a paper on the importance of sustainability and the principles of responsible industry procurement. The origin of materials has been found to be especially relevant as the reuse and recycling of materials may rely on the requirements of the material certified.

However, a sensitivity to the entire lifespan of the building motivates an impactful preservation. This includes planning, construction, environmental procurement, operation and demolition repair.

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It may also promote the compulsory Site Waste Management Plan, which is normally dependent on supply chain specifics (e.g. invoices, shipping notice, and inventory specifications).

1.3.3 Supply chain applications

These are only a handful of the many possibilities for advancing supply chain via blockchain. Some solutions span the whole supply chain, and new blockchain solutions that can help accelerate value creation and minimize costs are often released.

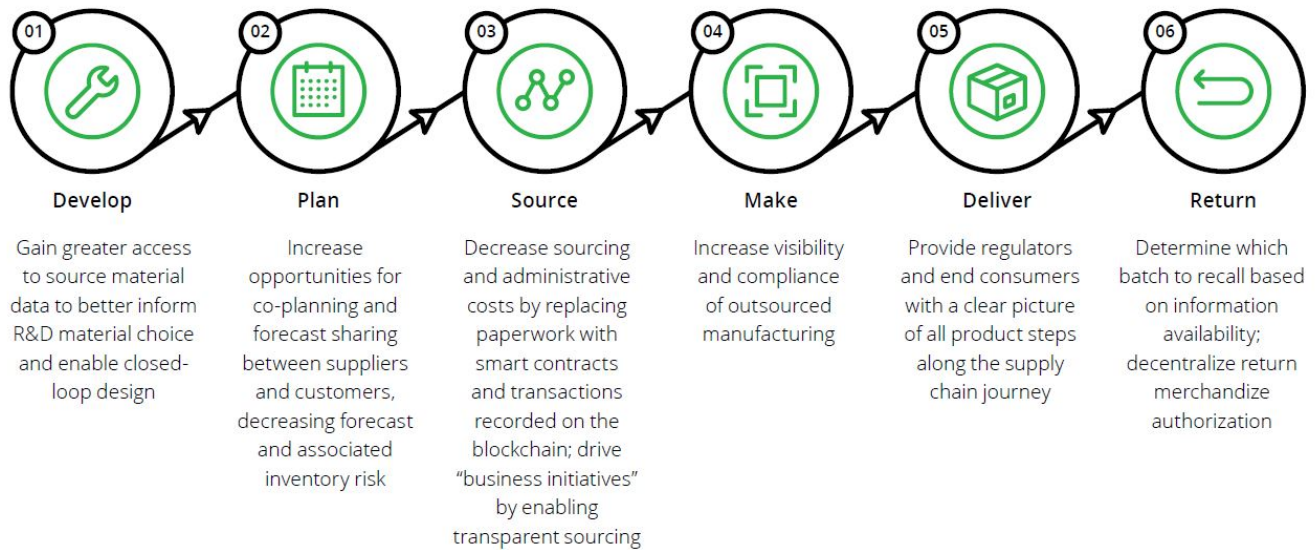


Fig 1.11 Supply chain application

1.4 APPLICATIONS FOR CONTRACT MANAGEMENT

1.4.1 Indian Contract Act, 1872

The Indian Contract Act is one of our country's oldest contractual laws. It went into effect on September 1, 1872, and applies to the whole country of India, with the exception of Jammu and Kashmir. It is the primary legislation controlling contracts in India, with a total of 266 parts.

The Indian Contract Act defines and validates contracts or arrangements with different parties. The Contract Act is one of the central laws that control and supervise all contractual dealings including a sale or an arrangement.

The Act as enacted originally had 266 Sections, it had wide scope and

- General Principles of Law of Contract – Sections 01 to 75
- Contract relating to Sale of Goods – Sections 76 to 123
- Special Contracts- Indemnity, Guarantee, Bailment & Pledge and Agency – Sections 124 to 238
- Contracts relating to Partnership – Sections 239 to 266

At present the Indian Contract Act may be divided into two parts:

- Part 1: deals with the General Principles of Law of Contract Sections 1 to 75
- Part 2: deals with Special kinds of Contracts such as
 1. Contract of Indemnity and Guarantee
 2. Contract of Bailment and Pledge
 3. Contract of Agency

1. Offer 2(a): When one person signifies to another his willingness to do or to abstain from doing anything, with a view to obtaining the assent of that other to such act or abstinence, he is said to make a proposal.
2. Acceptance 2(b): When the person to whom the proposal is made, signifies his assent there to, the proposal is said to be accepted.
3. Promise 2(b): A Proposal when accepted becomes a promise. In simple words, when an offer is accepted it becomes promise.
4. Promisor and promisee 2(c): When the proposal is accepted, the person making the proposal is called as promisor and the person accepting the proposal is called as promisee.
5. Consideration 2(d): When at the desire of the promisor, the promisee or any other person has done or abstained from doing or does or abstains from doing or promises to do or to abstain from doing something such act or abstinence or promise is called a consideration for the promise. Price paid by one party for the promise of the other Technical word meaning QUID-PRO-QUO i.e. something in return.
6. Agreement 2(e): Every promise and set of promises forming the consideration for each other. In short, $\text{agreement} = \text{promise} + \text{consideration}$.
7. Contract 2(h): An agreement enforceable by Law is a contract. Therefore, there must be an agreement and it should be enforceable by law.
8. Reciprocal Promises 2(f): Promises which form the consideration or part of the consideration for each other are called 'reciprocal promises'.
9. Void agreement 2(g): An agreement not enforceable by law is void.
10. Voidable contract 2(i): An agreement is a voidable contract if it is enforceable by Law at the option of one or more of the parties there to (i.e. the aggrieved party), and it is not enforceable by Law at the option of the other or others.
11. Void contract 2(j): A contract becomes void when it ceases to be enforceable by law.

1.4.2 Types of Construction Contracts

Construction contracts come in a variety of forms. Each category has benefits and drawbacks for both the owner and the contractor. They are split into two main categories depending on how they are paid to the contractor. The following are the most common types of construction contracts used in construction projects:

- Lump-sum contract
- Unit price contract
- Cost-plus contract
- Target cost contract

1.4.2.1 Lump-sum contract

In this case, the contractor submits a single fixed price offer on all of the project's operations. The contractor is in charge of calculating project costs based on drawings, and adding overhead and benefit to arrive at the project's expense. The contractor is responsible for all risks, and the owner is not responsible for them. The contractor has an advantage under this deal because he is credited for finishing early and penalised for finishing late. Since there is little room for changing the plan over the construction process, this contract is preferable because the project scope is clearly established at the design level.

1.4.2.2 Unit price contract

In a unit price deal, the overall price of the project is determined by the price of each item's unit. The bill of quantities specifies the prices at which the contractor is billed. The contractor and the owner are also responsible for the risk.

1.4.2.3 Cost-plus contract

The contractor is charged a specific fee plus the project's total expense, both direct and indirect expenses. This fee may be a set amount or a proportion of the total costs. The owner is responsible for all risks, and he collaborates with the contractor to oversee the job. There is no downside to the builder if the project's cost rises, and there is no pressure for an early completion. When the project scope is unknown in the early stages, this form of contract is ideal. Before completing the concept, the contractor will begin working on the job. Before the building is finished, it is difficult to determine the project's cost.

1.4.2.4 Target cost contract

The characteristics of a target expense deal are similar to those of a lump sum and a cost-plus contract. The contractor is charged on the basis of real costs plus a fixed or percentage of overall cost charge if the project's cost does not surpass a given target cost set by the owner. In the event that the cost of building work rises, the contractor bears a risk. A portion of the cost savings between the goal and real cost is therefore paid to the contractor.

Table 1.3 Comparison Between Different Types of Construction Contracts

Point of Differentiation	Advantages with respect to the contractor	Disadvantages with respect to the contractor	Advantages with respect to the owner	Disadvantages with respect to the owner	Flexibility of design changing
Lump-Sum Contract	Incentives for early finish	High risk	No risk Total cost is defined at early stages	Contractor desire to decrease costs may be to the detriment of quality	Limited flexibility
Unit Price Contract	Low risk	No incentives for early finish	Share risk with the contractor	Total cost is uncertain at the early stages	Has flexibility to change design
Cost Plus Contract	No risk	No incentives for early finish	Can start a project without finishing designs	High risk Total cost is uncertain at the early stages	More flexible to design stages
Target Cost Contract	Rewards for any savings between actual and target cost	Share risk with the owner	Target cost is defined at early stages	Share risk with the contractor	Limited flexibility

1.4.3 Blockchain for managing Contracts

Blockchain technology has the potential to transform the way existing contract management solutions operate. It will give rise to blockchain contract management - an ideal technology that will provide businesses with a way to master contract management.

1.4.3.1 Use of Smart contracts

Smart contracts are one of the blockchain's pillars. Smart contracts allow network automation and the conversion of paper contracts to digital contracts. Smart contracts can be perceived as legal codes of the same legality as paper contracts. By holding the two parties in operation, developers will establish a smart contract. When all agrees to the contract's terms, the contract is put into action, making it legal.

Since it is written in code, smart contracts can be used to automate processes. For example, if one party borrows money from another, the smart contract can be designed to store the loan number, interest rate, and other terms of the loan. Functions that can cause conditional acts can also be used in the smart contract. This means that once one party pays off their debt, the deal will either self-close or contact all parties interested in the smart contract.

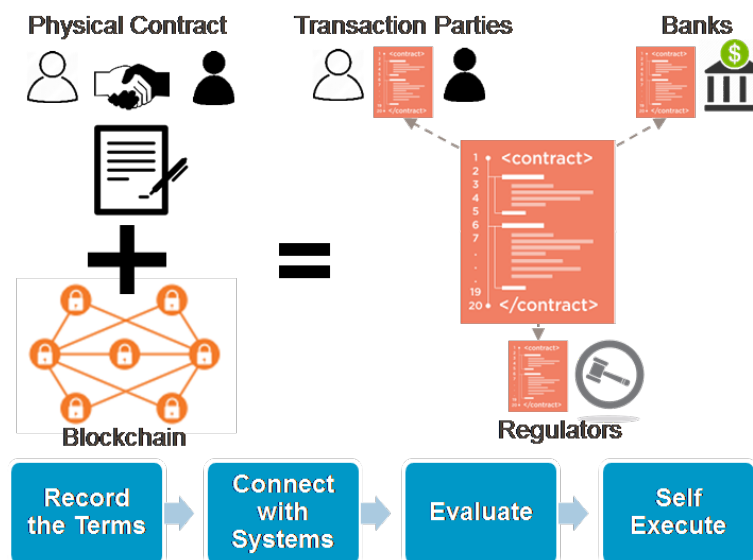


Fig 1.12 Smart contract operation

1.4.3.2 Advantages of using smart contracts for contract management

- No need for intermediaries
- Verifiable and Accurate
- Efficient and Cost-savings
- Enhanced security and data-backups
- Instant actions guaranteed
- Automatic management
- Improved Transparencies

1.4.4 Blockchain for managing Contracts

Blockchain technology has the potential to transform the way existing contract management solutions operate. It will give rise to blockchain contract management - an ideal technology that will provide businesses with a way to master contract management.

1.4.4.1 The time needed to formulate the contract

The time required to prepare, draft, and formulate a traditional contract ranges from one to several days, depending on the quality of the legal services and the readiness of the contract's parties. When using a ready-made contract platform, this period can be reduced to a few minutes for smart contracts

1.4.4.2 The execution and remittance of the contract

Conventional contracts obligate the parties to pay the amounts due on time - manually, with additional organizational effort on their part. The remittance in smart contracts is automated and executed automatically upon fulfilment of the conditions agreed upon and recorded in the code.

1.4.4.3 The final cost of the process

Smart contracts, in theory, do not require the intervention of intermediaries or third parties, so their cost is close to zero. For better or worse, this option remains a possibility in the uncertain future, and the role of lawyers in ensuring the contract's compliance with current legal regulations is significant. Smart contracts, with or without their intervention, are not only faster and more practical, but also a significantly cheaper option for negotiating parties.

1.4.4.4 The data security and protection

A smart contract, as opposed to a traditional contract, which is simply a piece of paper, can provide qualitatively new levels of security and confidentiality. Blockchain technology's cryptographic protection provides an unprecedented level of confidentiality, especially if the contract is stored on a private rather than a public ledger.

1.4.4.5 The need for physical presence

Given the dynamics of our ever-changing world, it is becoming increasingly important to conduct remote operations without compromising their reliability. A smart contract is signed with an electronic signature, which eliminates the need for the parties to be physically present - a disadvantage that traditional agreements do not have the ability to avoid.

1.4.4.6 The archiving

Traditional contract archiving requires time, space, administration, and oversight. It happens automatically, securely, and without wasting time or natural resources with smart contracts.

When compared to traditional contracts, the potential limitations of smart contracts include reduced contract term flexibility and the problematic "readability" of the contract by people lacking specific background and qualifications. Fortunately, both issues can be easily resolved with the assistance of an experienced lawyer who is familiar with the specifics of smart contracting within the confines of current legal regulations.

1.4.4.7 Conclusion

The distinction between the two types of contracts signals the beginning of a new era of agreement. Smart contracts are still new, and many questions remain unanswered, such as how the government will regulate them, how they will be taxed, and what will happen if the contract can't access the subject of the agreement. However, given the rate at which technology advances, it appears that things will be perfected in due time. Smart contracts will undoubtedly turn the hype into reality and will become an integral part of our daily lives.

1.4.5 Contract Workflows and Lifecycle Management

There are two fundamental concepts in contract management:

- Workflows for contract management
- Contract lifecycle management

1.4.5.1 Advantages of using smart contracts for contract management

The journey that a contract takes through your organization is referred to as contract lifecycle management, and it focuses on the various people and teams responsible for:

- **contract initiation**
- **comments and negotiation**
- **contract execution**
- **noting key dates and performance criteria**
- **storing the contract in your file management system for future reference.**

Contract lifecycle management takes a holistic view of the contracting cycle, whereas contract management focuses on the administration of individual contracts. The process of preparing, reviewing, negotiating, and executing contracts is referred to as contracting.

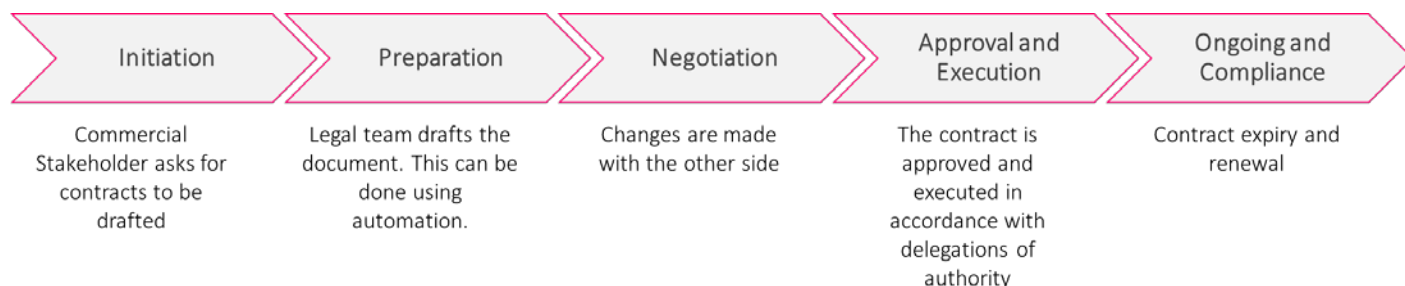


Fig 1.13 Contract life-cycle

1.4.6 Adopting the Right Tools and Systems for Your Contract Workflow

Workflow tools make it easier to move a contract from one phase to the next, alert stakeholders when action is required, and make it clear who is responsible for what in order to get the contract signed.

Workflow tools include:

- Automatically assigning new requests for legal assistance from the business to specific lawyers on your team (based on the type of request and the expertise of your team members)
- Dashboards and other live reporting that provide real-time updates on the status of various contracts (e.g., how many contracts are in the 'drafting' stage, how many are with a third party, and how many are awaiting signature) (instead of chasing up stakeholders via email).

It is possible to promote good contract management practices by using specific tools that relate to the objectives of different stages of the contract lifecycle.

Table 1.4 Contract Management Work flow tools for different phases

Phase of the Contract Lifecycle	Contract Management Workflow Tool
Preparation	Document automation: Instead of manually drafting and populating placeholders in contracts, team members can enter details into dynamic web forms (or questionnaires) which can generate contracts in a few minutes.
Negotiation	Clause libraries: Having pre-approved clause wording – covering both preferred and fall back positions – can help to speed up negotiations. Some contract management systems can also alert legal teams when a position in a clause library is changed.
Approval	Delegation of authority platform: This type of platform can assist business team members in navigating complex delegation of authority protocols by asking a series of questions about the contract. It can also direct them to the appropriate person to approve the entry into a specific contract.
Execution	Electronic execution: This allows multiple parties to quickly sign the same contract. It can also include automated reminders to sign, eliminating the need to print multiple hard copies and chase down missing signatures.
Ongoing compliance	Automated reminders: Reminds the organization of payment and other performance milestones, such as product delivery dates.

1.4.7 Benefits of Good Contract Lifecycle Management and Effective Workflows

There are several advantages to developing and maintaining good contract lifecycle management and contract management workflows. These are some examples:

- **Lowering the likelihood of legal errors**
- **Encouraging adherence to corporate governance protocols**
- **Lowering risk**
- **Increasing visibility**

1.4.8 Key Takeaways

If a company uses multiple contracts to deal with vendors and clients, it must have strong contract lifecycle and workflow management systems in place. This includes processes for optimizing contract administration and increasing the efficiency of each step of the contract's drafting, execution, and storage. Strong management systems will assist you in minimizing legal errors, navigating corporate governance protocols, minimizing risk, and maximizing resource utilization.

CHAPTER 2

LITERATURE REVIEW

2.1 PAPER REVIEW 1: BLOCKCHAIN READY MANUFACTURING SUPPLY CHAIN USING DISTRIBUTED LEDGER

Authors: Saveen Abeyratne and Radmehr Monfared / Published by Radmehr Monfared on 12 October 2016.

2.1.1 Summary

Through exploring different opportunities and tools and integrating various Blockchain Applications, Blockchain has revolutionised many industries. Blockchain 1.0 is popular for its economical, enterprise and financial uses and Blockchain 2.0 for apps outside the currency, finance and markets while Blockchain 1.0 was initially used for crypto-monetary applications. This study aims at using applications of Blockchain 3.0, in which Blockchain's decentralised accounting mechanism is used for the carbon incorporated in building supply chains.

2.1.2 Blockchain Technology

Blockchain is a distributing, open ledger technology that incorruptibly creates, validates and records cryptographic digital entity transition. All transactions on a Blockchain are stored in a single database, where each user saves a copy of the database that does not result in a single point loss as in normal relations. Without tracking transactions from any third-party entity, Blockchain provides data encryption, anonymity and integrity. The key elements include distributed ledger technology, a digital ledger, a transaction confirmation mechanism and a network of node operators.

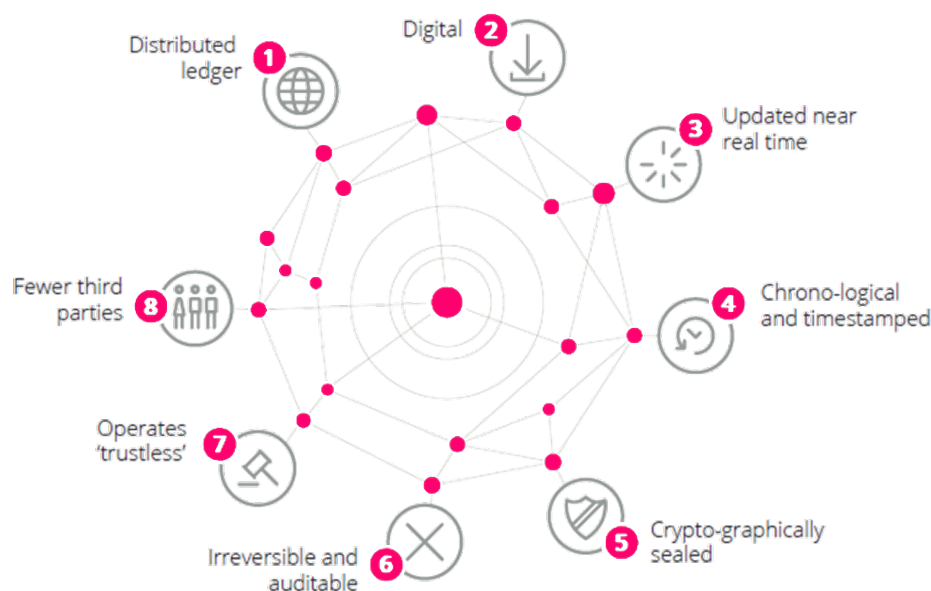


Fig 2.1 Distributed Ledger Network

Blockchain has begun to revolutionise a number of sectors, with Blockchain 1 generation being developed for digital currency, digital banking Blockchain 2.0 and digital banking Blockchain 3.0. Not only traditional businesses can be upgraded, but Blockchain-based technologies can also provide new business opportunities.

2.1.3 Blockchain 1.0

Blockchain was first used by the cryptocurrency system to validate and store Blockchain level 1 transaction data in a secure way. Blockchain's key advantage for digital currency is that it provides a credible way to transfer money without the involvement of reliable intermediaries or counterparties.

2.1.4 Blockchain 2.0

Blockchain 2.0, which was further categorised into a number of classifications including financial transactions, public records, Identification, private logs, etc., was introduced for financial, enterprise and financial applications such as equities, equities, intellect money, smart contracts.

2.1.5 Blockchain 3.0

For non-financial application of distributed ledger systems, Blockchain 3.0 was introduced. Combination of other government, education and finance-related practises lets those non-financial activities convey monetary assets in Blockchain 2.0 and Blockchain 3.0 implementations. As is the case for Blockchain 3.0, supply chain management is one of the key areas for evaluating the deployments of Blockchain mainly in relation to logistics.

2.1.6 Potential use in Construction Supply Chain

In the supply chain, a popular, consensual public ledger is used to track product/service origins and processes. The potential management of supply chains using Blockchain provides businesses with increased traceability, transparency and streamlined procedures. Blockchain used in supply chain management will also provide all stakeholders with certificates and documents and knowledge of the product lifecycle. The stock can be tracked from the manufacturer and taken to the distributor or store in transit. In the same way, each object can also be traced to the site in building information management (BIM) models on a blockchain and linked to the digital version of the same thing. Throughout the life cycle of the project, the immutable database will then be saved and stored. It also provides increased security and trust and responsibility for auditing purposes between the suppliers and customers.

2.1.7 Inference

Public key encryption used in Blockchain enables consumers to have more trust and security. In a decentralised Blockchain, anyone can access and take part in a network but only if sufficient nodes are able to agree the transaction is legal will a transaction be registered in the block. Only those members in a private Blockchain can join the peer-to-peer network, and only a small number of participants can link, follow and connect transaction with the Blockchain.

2.2 PAPER REVIEW 2: DESIGNING A BLOCKCHAIN-ENABLED SUPPLY CHAIN

Authors: Yingli Wang / Published by IFAC Papers Online 52-13 (2019) 6–11

2.2.1 Summary

The analysis reports a case study by a UK-built group that tries to pilot an smart contract initiative. We use a sense-making theory at the pre-pilot level to clarify how supply chain participants contextualise the potential Blockchain impact on their businesses and diagnose a new one. Symptoms of the technology and the current technology are then assumed, desired and understood and form a potential pilot component. In the pilot, in conjunction with the theoretical business method objective, we use the design science approach to systematically shape the application of Blockchain.

2.2.2 Sense-making

The way people attribute value to their shared knowledge is the process by which they make sense of it. Sense-making aims to analyse the understanding and positioning of company members with the adoption of emerging technologies.

2.2.3 Research Methodology

There was a qualitative, participatory review method. The techniques for designing scientific experiments in particular affect this research. The thesis has been divided into two phases: the first part focuses on the pre-pilot sensing process. The second stage involves piloting an smart contract initiative involving a number of players in the supply chain.

Table 2.1 Organization members of the initiative

Organization Name	Type of Supply Chain Actor
design.	Designing company
Steel Co.	Manufacturing company
ITCo1	Supply chain Consortium lead
ITCo2	Blockchain solution provider
ITCo3	3D business applications provider
ITCo4	Costing estimation solution provider
Independent consultant1	Project management
Consult Co.	Main contractor

Law Co.	Lawyer and regulative agency
Supplier1	Supplier
TA	Trade association
Academic	Knowledge transfer and academic advisor

2.2.4 Sense making by Supply Chain actors

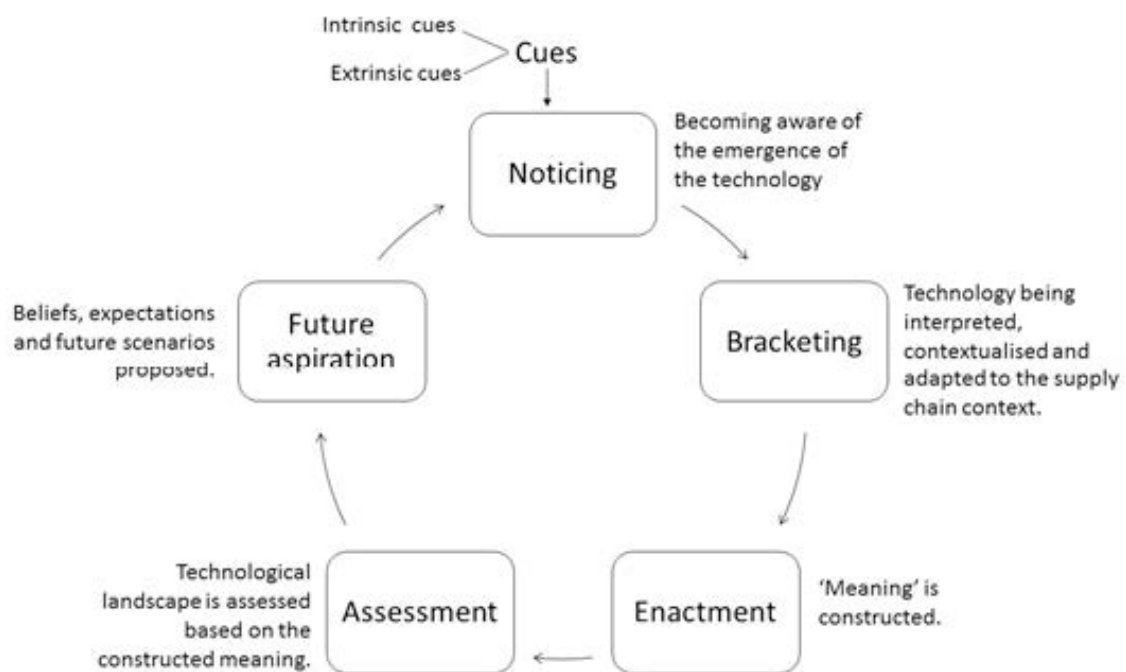


Fig 2.2 The process of sense-making of the Blockchain technology

- In essence, sense-making is a social mechanism of creation and rebuilding, through which administrators build a sense for themselves to grasp what is going on. Blockchain technology is a closed-loop mechanism caused by cues.
- Cues may be intrinsic (the inherent characteristics of the invention such as its perceived ease of use, efficiency, and utility) and extrinsic (non-physical characteristics such as its perceived appearance and price/cost).
- In this research, the combined intrinsic and extrinsic frameworks of the participants contributed to increased confidence in and anticipation of Blockchain technology.
- The participants' intrinsic structures were based on the utility and efficiency and ease of use of the Blockchain required to be adopted.
- The technical features of Blockchain trigger the mechanism of human understanding and form the foundation of the process of interpreting the whole technology through top management.

2.2.5 Inference

The analysis reports a case study by a UK-built group that tries to pilot an smart contract initiative. We use the architecture scientific method to systematically influence application of Blockchain during the pilot in conjunction with the theoretical lens of the business model. The business model approach provides a systemic platform to influence the attention of individuals, deliberations and decisions on Blockchain, as well as a collaborative activity platform for community members to achieve a common goal and value-advanced growth. The research also helped the practitioners. The intellectual mechanism of meaning among senior managers allows firms to take into account the multifaceted views of the application of Blockchain and the thinking behind such mental model.

2.3 PAPER REVIEW 3: BLOCKCHAIN READY MANUFACTURING SUPPLY CHAIN USING DISTRIBUTED LEDGER

Authors: Saveen Abeyratne, Radmehr Monfared / Published by Radmehr Monfared on 12 October 2016.

2.3.1 Summary

As a platform for distributed leads, the Blockchain system offers an innovative forum for new, collaborative and transparent computing for industry and enterprises. The inherited characteristics of this technology strengthen the trust in any transaction that involves data, goods and financial resources by transparency and traceability. The writers analyse the existing state of the technology and certain its application in this article. This article explores the potential benefits of such innovations in the global supply chain and provides a blueprint for the emerging Blockchain ready-made supply chain.

2.3.2 Need for Transparency and Traceability in Manufacturing Supply Chain

- More and more complex, large and multinational supply chains are growing. The production or delivery of a service may stop with an event on one side of the planet. The occurrence could be a natural cause or a causal one, maybe a minor one, or perhaps a significant one.
- However, small ones may have serious counter-productive consequences on companies if the supply of a crucial item or service is delayed. The supply chain will be farther down, both economically and prestigiously.
- Moreover, some potential negative consequences such as ecological destruction, end-of-life waste, unethical work and forged products may be involved. Transparency in the supply chain is a major market concern for most companies having little to no information on second and third-tier suppliers.
- Openness and access to the supply chain can help model the delivery of products from raw materials to the manufacture, testing and finished products, allowing for innovative ways of analysis on service, risk and sustainability.
- The fact that you rely on a single agency to provide such sensitive and valuable information gives everyone in the supply chain a great deal of trust. By keeping those valuable information, such organisations may also play a major role in extortion or harming organisations.

2.3.3 Manufacturing Supply Chain using Blockchain Technology

- With the use of permanent data capture, distributed storage, and supervised user access the technologies of Blockchain will theoretically improve transparency and traceability within the supply chains. This paper proposes a transparent delivery system that uses technology from Blockchain to record, store and process important product data of each particular product during its life cycle.

- A distributed information block can create a secure, public transaction record with unparalleled product information for each product.
- The proposed framework is explained in the following pages, including the types of actors in the supplier network, how they enter and record themselves in the network, and how data entry is allowed, authenticated, and stored.

2.3.4 Blockchain Ready Manufacturing Supply Chain

This figure describes Blockchain's possible application of distribution networks in the supply chain. The idea suggested is a decentralised distributed ledger that uses Blockchain(s) to record, store and manage key information during its life cycle for every device. This provides a consistent and commodity exchange record and specific product records.

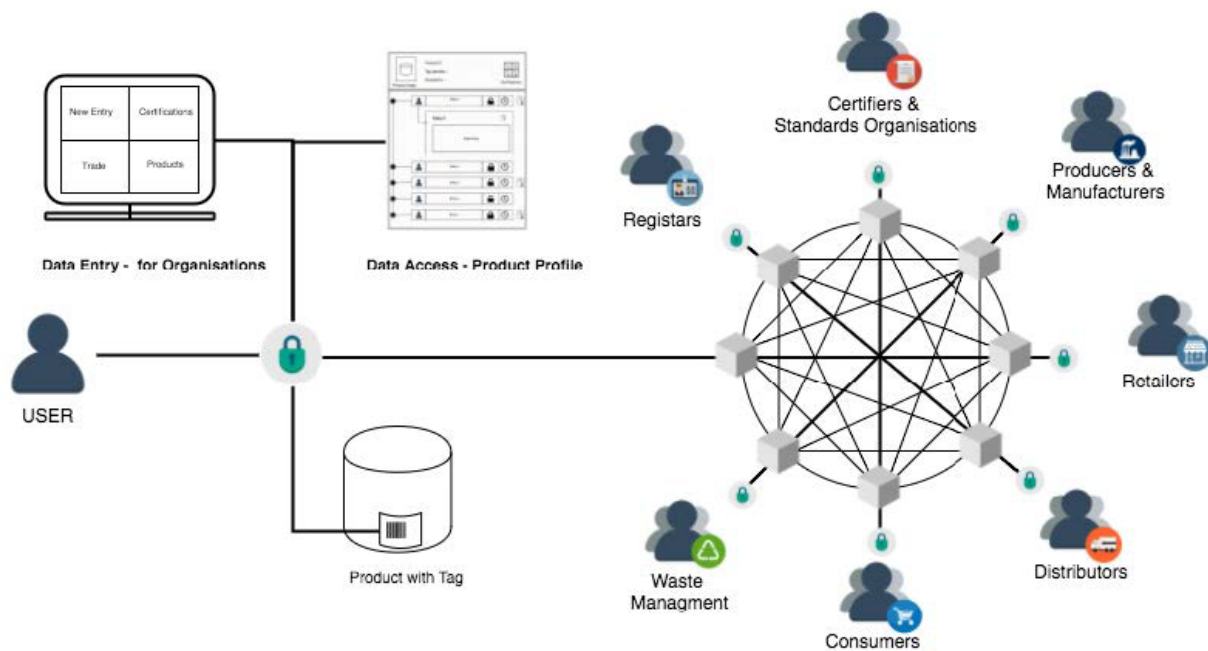


Fig 2.3 Overview of the proposed concept

A barcode, an RFID or a QR code is attached to the packet. Each box has a barcode tag. This tag represents a digital encryption identifier that links the physical product with its network virtual identity.

The actors will also have their digital network profile generated when they register. This profile shows the definition, location, certificates and product associations. There are several categories of actors in this system:

- **Registrars** – offers exclusive identity for actors on the network.
- **Standards Organizations** – establish standards systems (e.g. fair trade)
- **Certifiers** – offers certifications to actors that enable them to engage in the network.
- **Producers, suppliers, dealers, retailers, and waste control organizations** – join main product-specific data on the Blockchain.
- **Consumers** – purchases goods and can, in certain situations, enter product data on the Blockchain.

Each actor using this platform has connections through a user interface to a specific Blockchain network. For the particular digital product profile, the technological platform used by the players is tailored. The software

is developed by a consortium of trustworthy companies, and licenced organisations and individuals can connect and operate on their networks.

2.3.5 Data Access

The product digital profile is the key entry point for all of the players in this scheme to product details. Each entry is time-stamped and the actors digitally signed. Product-related certifications are also registered in the product's digital profile. This figure shows the access as a locked or unlocked mark for each entry, which shows each user who accesses this profile.

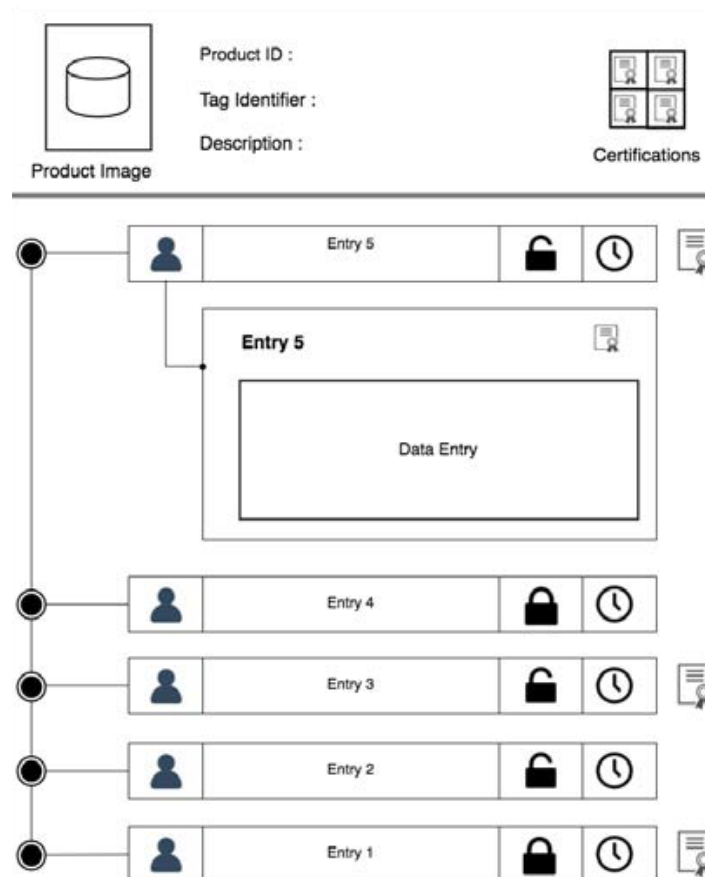


Fig 2.4 Example template for a product profile

2.3.6 Application Scenario

A model scenario to further explain the potential of the proposed definition is discussed in this section. For the raw materials, processing, shipping and recycling of the cardboard case the application of the supply chain Blockchain shall be considered. In this case, we focus only on a single branch of the supply chain, which includes the extraction of raw materials for paper, the conversion to a card box, its use as packaging and, finally, the method of recycling as described in the image below.

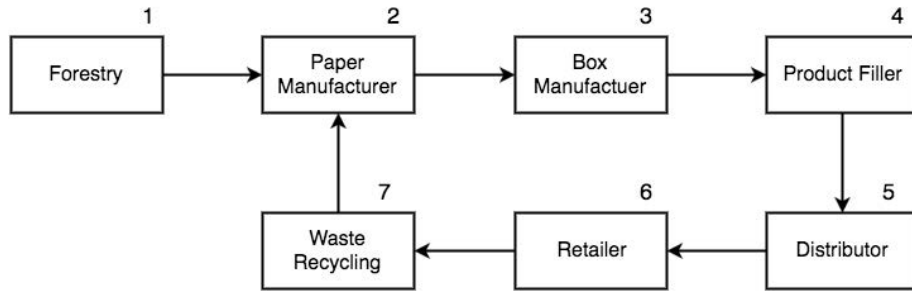


Fig 2.5 Part of the manufacturing supply chain for a cardboard box

A barcode, RFC or QR code can be attached to any box with an information sticker. This tag represents a digital encryption identifier that links the physical product with its network virtual identity. The actors will also have their digital network profile which is generated when they register. This profile provides details such as definition, venue, certifications and product associations.

2.3.7 Inference

Blockchain technology is a revolutionary development that transforms many of today's traditional systems into more stable, distributed, open and collaborative systems and inspires people. The authors discussed in this study some of the core features of Blockchain technologies and investigated potential areas of use. The report then focused on the execution of manufacturing companies within the supply chain. From processing to recycling it has been explained a hypothetical vision for a ready-to-use Blockchain supply chain and an example scenario for part of the supply chain for box production.

2.4 PAPER REVIEW 4: A SMART CONTRACT SYSTEM FOR SECURITY OF PAYMENT OF CONSTRUCTION CONTRACTS

Authors: Salar Ahmadiheykhsarmast, Rifat Sonmez

Published by: Department of Civil Engineering, Middle East Technical University, Ankara 06531, Turkey

2.4.1 Summary

Plan partners must be paid promptly in order to carry out building programmes effectively, but the building industry suffers internationally from an insufficient payment policy. Current experiments examined the causes and consequences of the payments crisis, but very few studies proposed solutions to the issue. This paper proposes a new intelligent payment system called SMTSEC for the removal or reduction of problems in the payment sector. SMTSEC ensuring the optimised computerised protocol that works on a joint blockchain, ensures the entire settlement of contracts for buildings.

2.4.2 A Smart Contract System for Security of Payment of Construction Contracts

The protocol proposed is designed to ensure that payments for building works are secured through smart contracts. The first step in the process is to establish the terms of payment confidentiality, between the employer (EM) and the principal contractor (MC). Via a smart contract deployed on a blockchain, the negotiated conditions are provided as a computerised protocol. Using the project's expected cash flow, the planned success reward rate will be calculated for the next payment date.

The smart contract protocol allows the planned payment to be blocked by early next month in order to ensure progress payments are secure. The smart contract directly passes progress payment amounts to the accounts of vendors, subcontractors and providers according to the negotiated terms and conditions immediately after the employer's approval of progress payment. In order to ensure payments for the next period the smart contract blocks the expected advance payment sum for the next period, along with the allocation of the funding. For the next payment cycle the process is repeated before completion of the project.

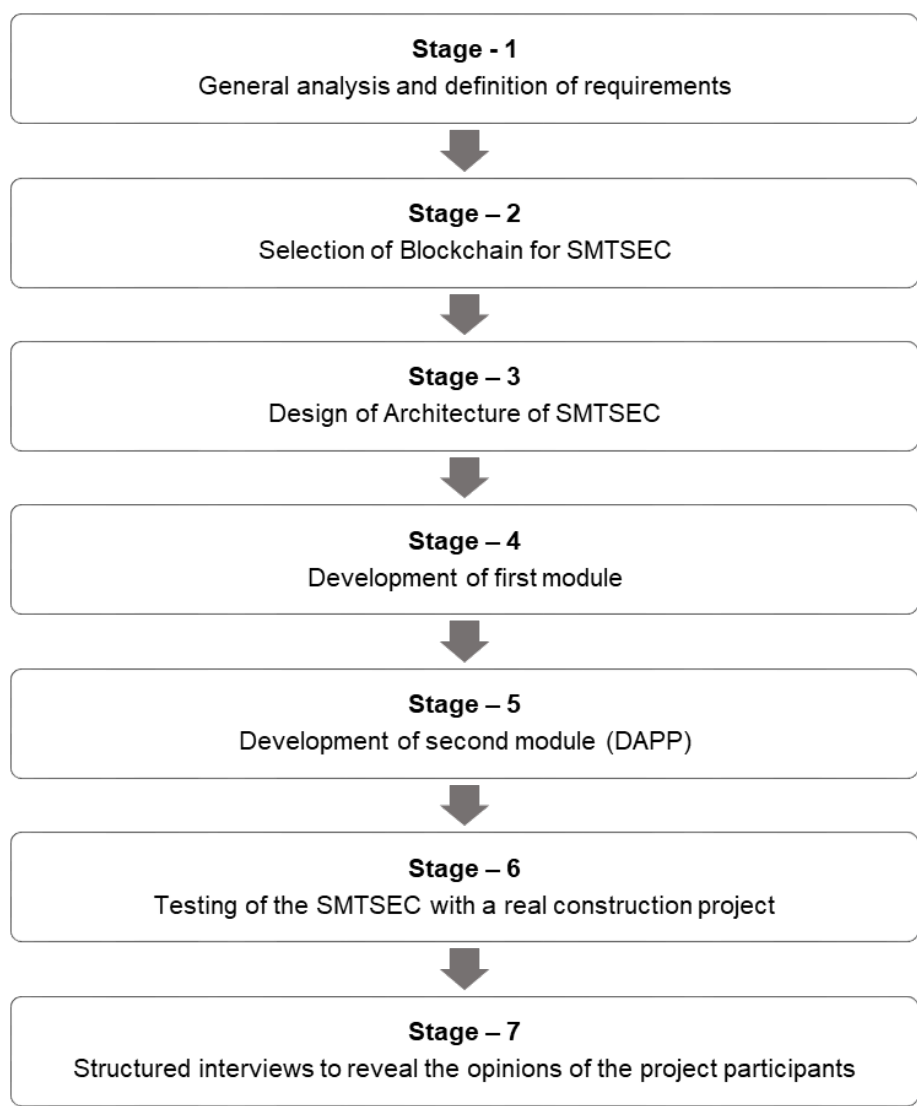


Fig 2.6 Stages of smart contract system for security payment

CHAPTER 3

CASE STUDY

3.1 CASE STUDY – 1: BLOCKCHAIN TECHNOLOGY FOR DIGITAL CONTRACTING - ACCENTURE

An interview with Mr. Muralidharan – Technical Head – IT department (Accenture, Chennai.)

The last ten years have passed by negotiations, and each company undergoes rigorous efforts to draw up contracts, which often have to be dealt with over time. A number of people are involved in the procedure, which involves different stages and many modifications. "There must be a better way," said Accenture Internal IT Unit, which is still searching for fresh, innovative concepts.

The idea was for Accenture and its clients to securely store paper contracts on a blockchain database, allowing each party to access, review, and agree to changes. As a result, the development of 'smarter contracts' with definite digital records held electronically in the same place would only be open to parties with access, and with copies and operations expressly registered.

A cross-functional expert task force led by Accenture's internal IT organization, established "proof of existence." In the same region, with trust and security measures in effect, where the two parties have access to the same contract, all the parties have access to the final and right version.

A dedicated Project Team has established a website for the solution implementation, document contract acceptance and method industrialization. Since blockchain technology is at the back end of the network, which acts as a centralized source of reality, each company will enter into a contract on its front end.

All parties also have access to a live contract, and a tamper-evident audit trail provides every amendment to the contract. The creation of smarter contracts is enhanced with a central database, which constantly houses the latest negotiated iterations. This saves space, paper and environmental waste for the physical storage. Accenture's Contracts Blockchain is the newest technological trend of contract administration revolutionizing the schedule, change and handling of contracts.

3.2 CASE STUDY – 2: TATA STEEL PILOT WITH THE CONSTRUCTION SMART CONTRACT COMMITTEE & IBM

Tata Steel has invested to create a traceable custody chain for its products as a manufacturer with Responsible Sourcing-BES 6001 certification. From raw materials to in-use, along with manufacturing specifications and conditions relating to all the applicable parameters. This details and supplier records are however accessible on request instead of only live connected to digital data for a particular product, as usual for suppliers.

A unique id which is saved on a blockchain framework is used to track any ray. This digital identification (also known as the digital content passport) makes all the conditions of manufacturing and development available and transparent to the relevant parties. As the steel beam transfers each control change's supply chain, transport data on the blockchain linked to the actual beam is applied. This allows the beam to be easily linked, after installation, as a tagged asset, to the BIM project model with its unique ID and all construction and procurement information, with the option of being connected live to a continually updated vendor specification database.

Such a deployment of Blockchain offers a highly efficient method to handle on-site steel materials and allows all future collaborators the trust to quickly meet their obligations to share their origin codes, such as fire reports.

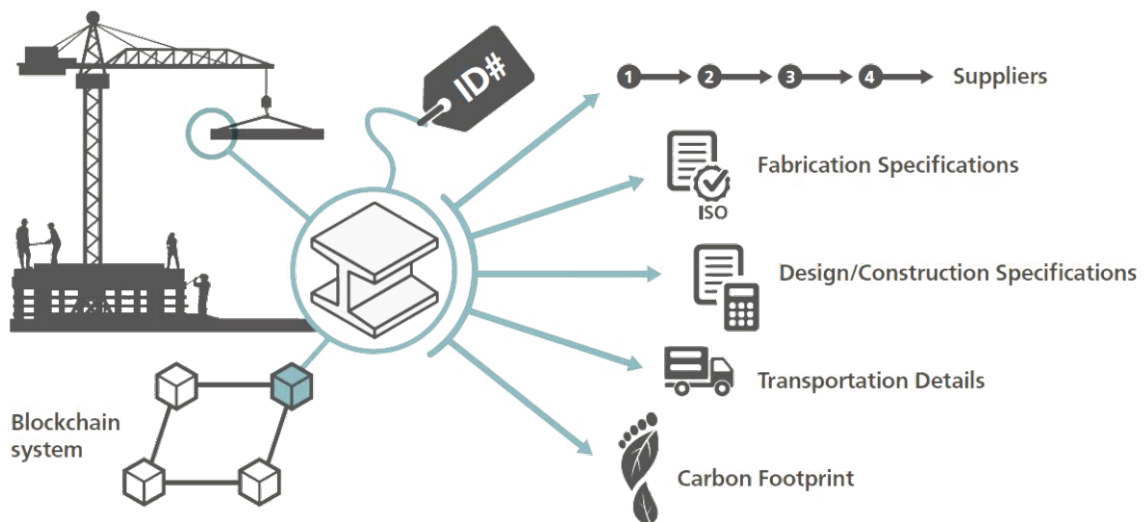


Fig 3.1 Blockchain based provenance of a steel beam

3.3 CASE STUDY – 3: BLOCKCHAIN-ENABLED SHIPPING PLATFORM

In 2017, Maersk and IBM revealed a blockchain technique to digitize the entire trading workflow and provide an end-to-end infrastructure to monitor millions of cargo containers per year. One recently illustrated case shows that flowers were shipped in about 200 confirmation papers and communications from Kenya via the port of Rotterdam. The farmer simply sends a packaging list under the new system using a PC or a mobile computer (visible to everyone immediately).

This enables a smart contract to create a blockchain digital export workflow, requiring all companies and parties to submit permits and digital licenses while the cargo is passing through the supply chain. Both shipping specifications, necessary documents and digital signatures are simultaneously updated to streamline the process and track the transport of the shipment and accessible to all stakeholders.

Inadequate point- to-point and handling would reduce complexity, scarcity and fraud, saving billions of dollars every year, thanks to this blockchain platform



Fig 3.2 Lenovo (2017) A Server OEM's Perspective on Containers

CHAPTER 4

ANALYSIS

4.1 QUESTIONNAIRES, INTERVIEWS AND ANALYSIS

The goal of the interviews is to gain preliminary knowledge in the field of Blockchain. This survey gathered information from people working in and out of the construction industry, all of whom had varying levels of awareness about Blockchain. The research was also conducted with people who had no prior knowledge in order to obtain new and creative ideas that had not previously been established. Instead of presenting each answer word for word, the researcher chose to provide a summary of each conversation to the reader. The following are the general questions that were asked, but the conversations were semi-structured to allow the source to explore new ideas.

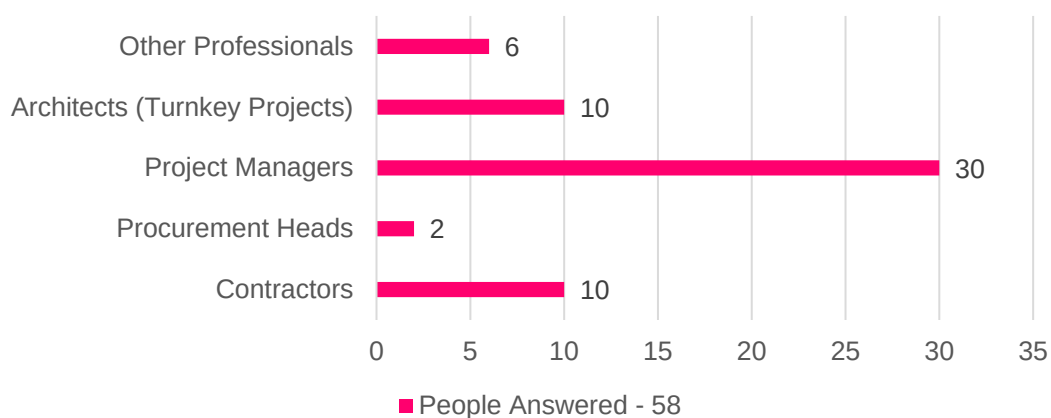


Fig 4.1 Total no. of people answered

Secondly, we needed to know whether they preferred an uplift or a development in the practices that are currently followed in our construction industry. And how efficient is the current conventional method.

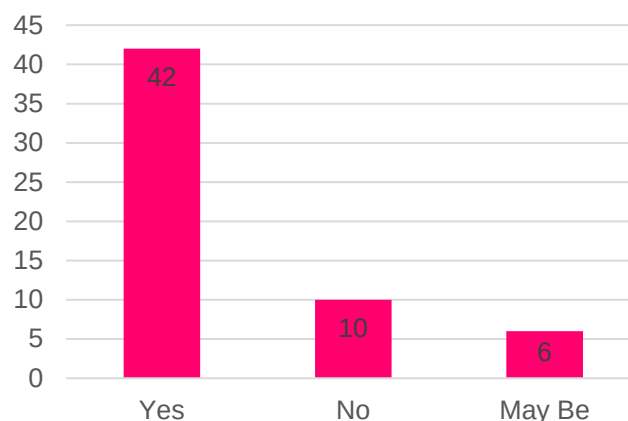


Fig 4.2 Preferences to Uplift

Will implementing Blockchain and Smart Contracts into construction be Productive and Efficient? The arrived values are ranked according to their importance (1 - Being the lowest and 5 - Being the highest)

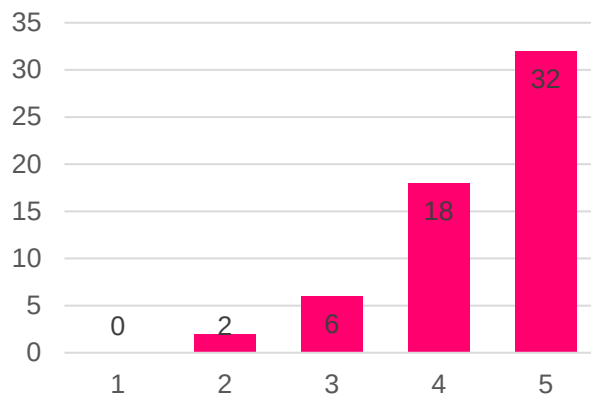


Fig 4.3 Productive and Efficiency

The below chart mentions the following technologies that the people in construction industry are aware of / Have you heard of Blockchain and Smart Contract technology and what do you know about this implications?

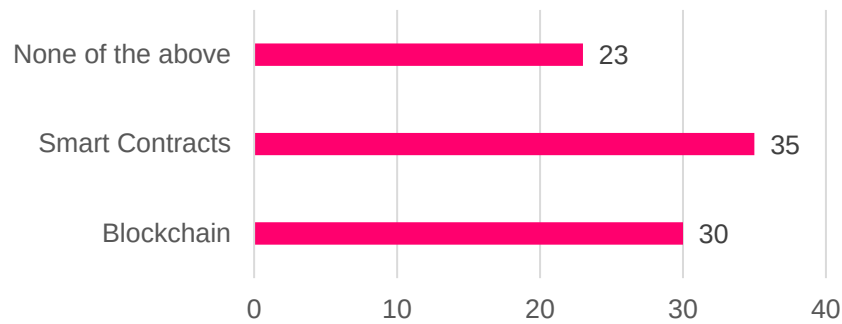


Fig 4.4 Technologies in construction industry

What type of companies can use this Blockchain and Smart Contracts in Construction sector?

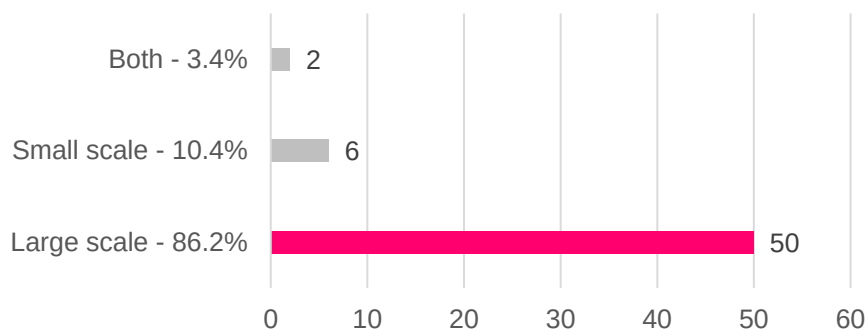


Fig 4.5 Companies that can use these technologies

To implement Blockchain and Smart Contracts in construction industry, do you think standardization of contracts is necessary?

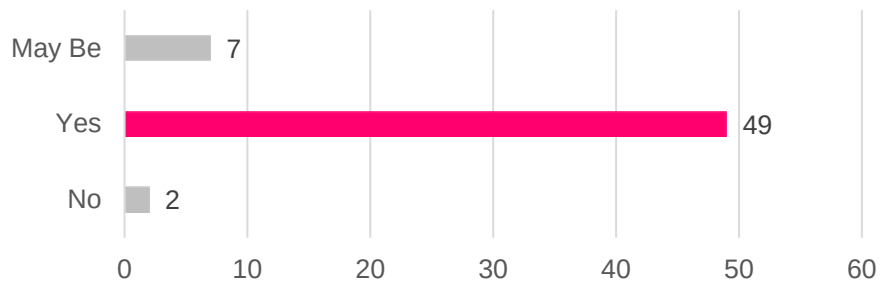


Fig 4.6 Standardization of contracts

What would be the benefits of standardizing the contracts? Accuracy / Transparency / Traceability / Risk Management / Cost Effectiveness

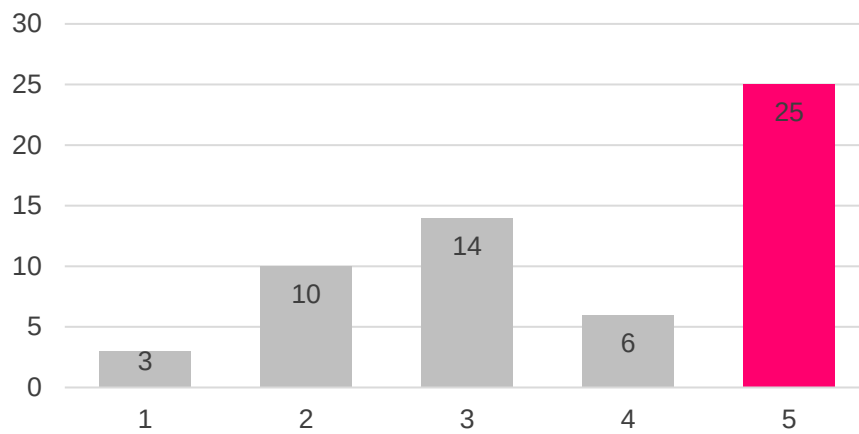


Fig 4.7 Accuracy

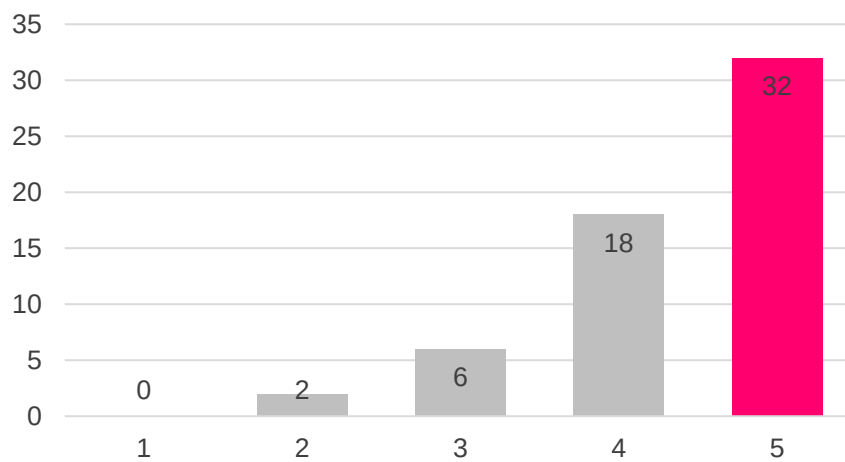


Fig 4.8 Transparency

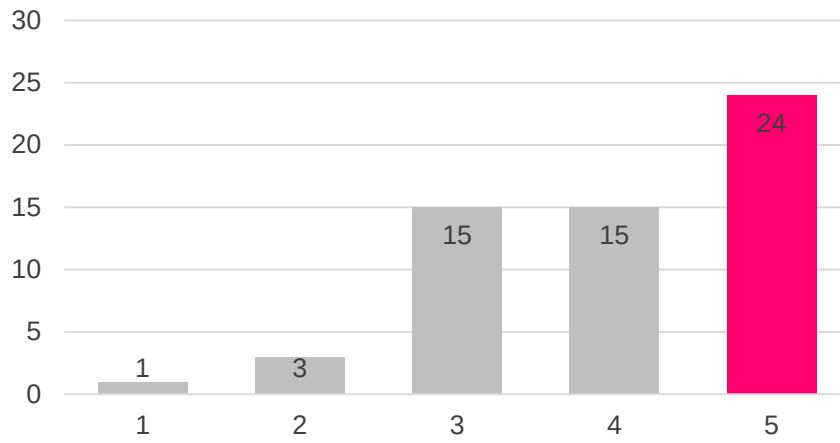


Fig 4.9 Traceability

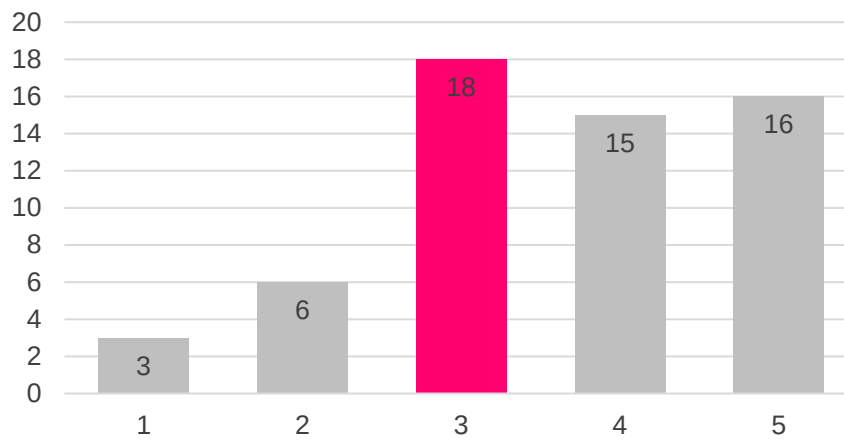


Fig 4.10 Risk Management

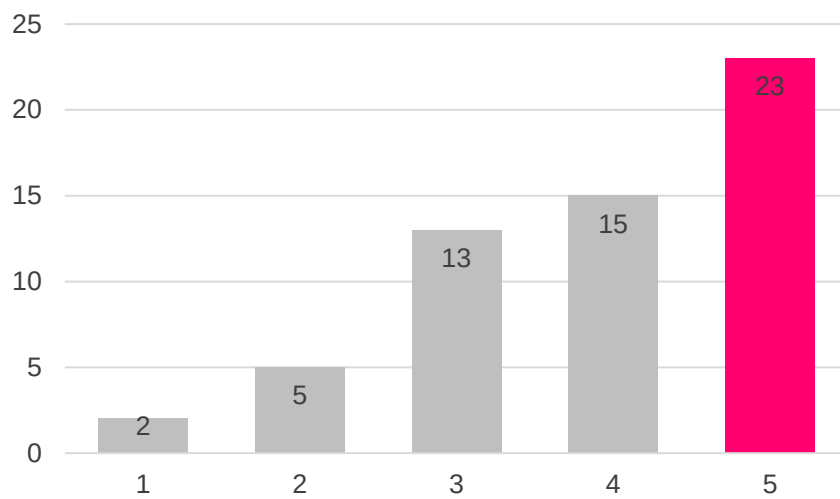


Fig 4.11 Cost Effectiveness

4.1.1 Calculated Mean Chart

This table represents the ranked factors according to their mean. The highest ranked factor is Transparency and the lowest is Risk Management

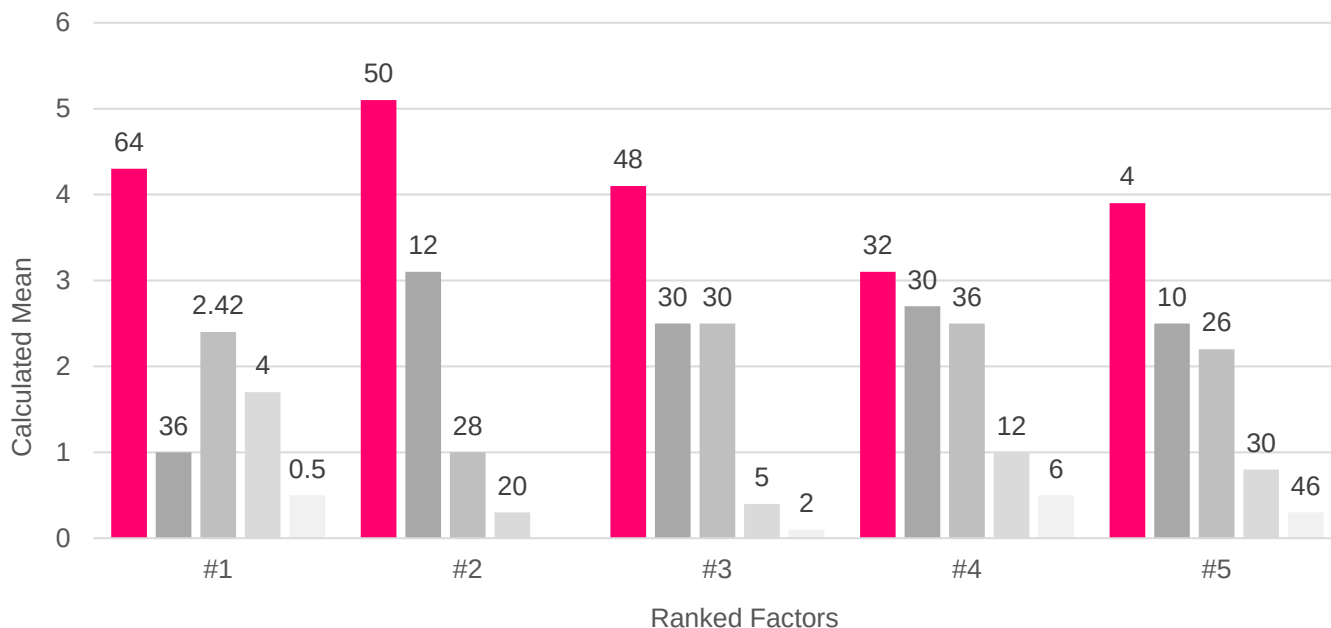


Fig 4.12 Calculated Mean Chart

Which area in construction industry do you think Blockchain and Smart Contracts be more effective?

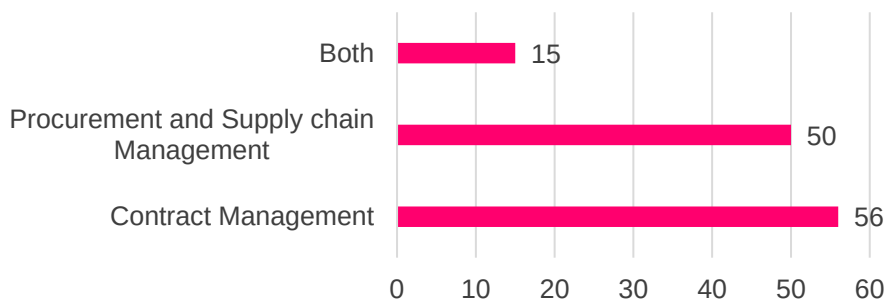


Fig 4.13 Area – Blockchain and Smart contract can be used

Would a construction company owning their own Blockchain built specifically for their company be useful? Or would a general Blockchain built for all contractors be better?

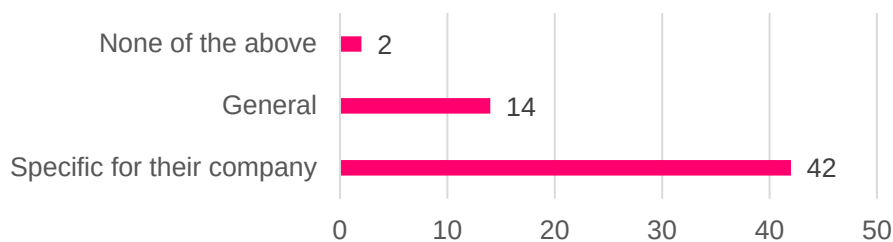


Fig 4.14 Owning Preferences

Will our country consider blockchain smart contracts to be legally binding?

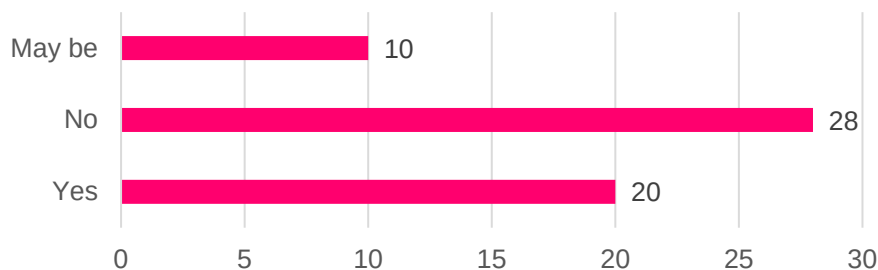


Fig 4.15 Legalization by Government

4.1.2 Responses collected from Questionnaire

4.1.2.1 Adarsh Chandhranadhan – Road Infrastructure Development (L&T Ahmedabad)

Smart contracts have the potential to significantly alter the way projects are carried out. The construction industry has long been plagued by the issue of value leakage throughout the supply chain. The use of smart contracts in construction projects can improve project stakeholder's ability to complete projects on time and within budget. Smart contracts can be used to improve commercial controls, provide more accurate performance measurement, and align contract interpretation.

4.1.2.2 Ar. Tahaer Zoyeb – Architect (Turnkey Projects)

I think primarily, the biggest change will be the technology helping to establish transparency on the execution of a large project and Smart contracts are currently not legally binding. They are machine-readable and need to be executed by a human to make legal.

4.1.2.3 Mr. Suresh – Procurement Lead (L&T Ahmedabad)

Blockchain, in my opinion, is useful in many ways, including speeding up contractual processes, payment processes, and tracking quality. While it has the potential to be very beneficial to the industry, I do not believe it will be fully implemented anytime soon. This technology is still in its early stages, and many people have no idea what it is. The industry will adapt to change slowly, but once it does and realizes how beneficial it can be, we will begin to see some productivity gains. Construction is a highly complex industry and we must figure out how to meet the growing demand for construction while also delivering high-quality projects around the world.

4.1.2.4 Gowri Shankar – Contractor

While Smart Contracts are still in their early stages and are unlikely to be ready for implementation, the technology's future looks promising. Smart Contracts could be used by general contractors for self-enforcing conditions that must be met. This could include self-monitoring of milestones as well as automatic payments to subcontractors who meet these deadlines.

4.1.3 Contract Workflow Derived

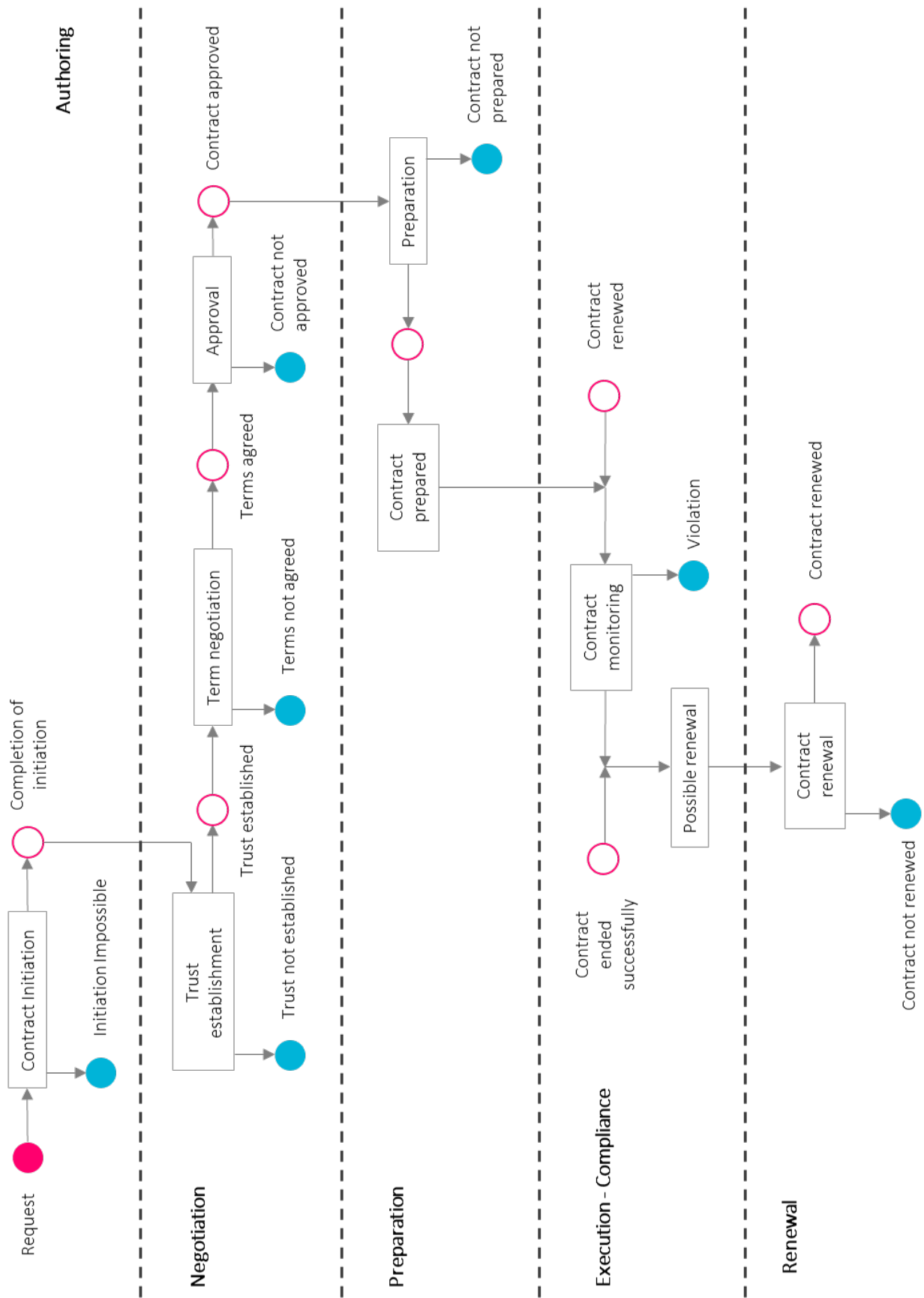


Fig 4.16 Contract Workflow

4.1.4 Smart Contract – Workflow

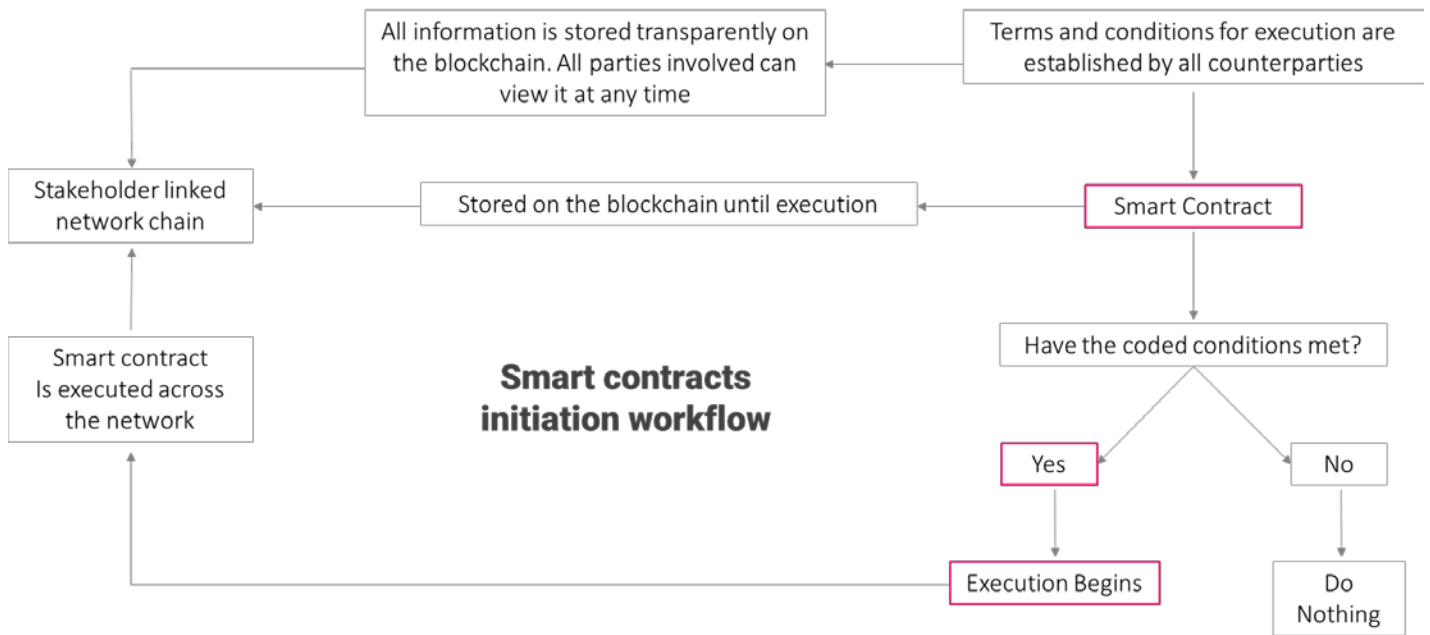


Fig 4.17 Smart Contract Workflow

4.1.5 Blockchain – Collaborative Eco-System

Blockchain provides a radically new way of using information technology to facilitate business collaboration. We can see the shift from messaging-managed binary families to holistic communities of organizations with common processing logic and a single "source of truth" database. Once the advantages and opportunities of a common source of reality are grasped and used, current approaches to handling business processes and activities can be extended and transformed. It also presents difficulties for companies that are "on-boarding" to Blockchain, as techniques are needed to enable seamless integration between Blockchain-hosted processes. It also presents difficulties for businesses "onboarding" to Blockchain, as techniques are needed to enable smooth convergence between Blockchain-hosted processing and legacy processing that remains.

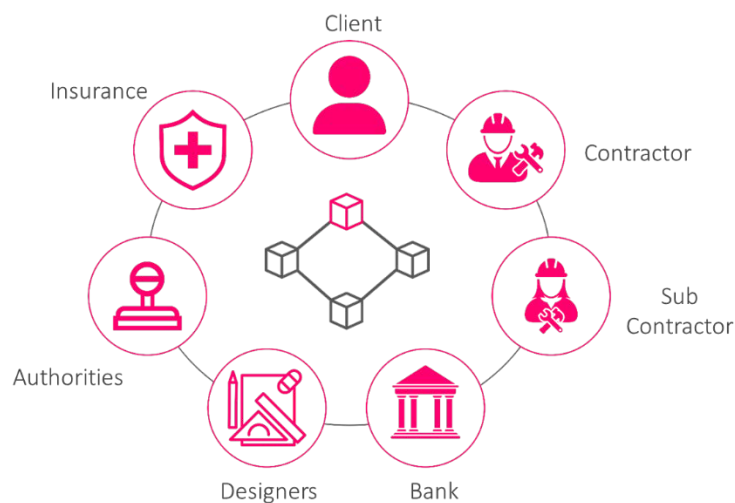


Fig 4.18 Collaborative Eco-system

4.1.6 Blockchain and Smart Contract – Flow Diagram

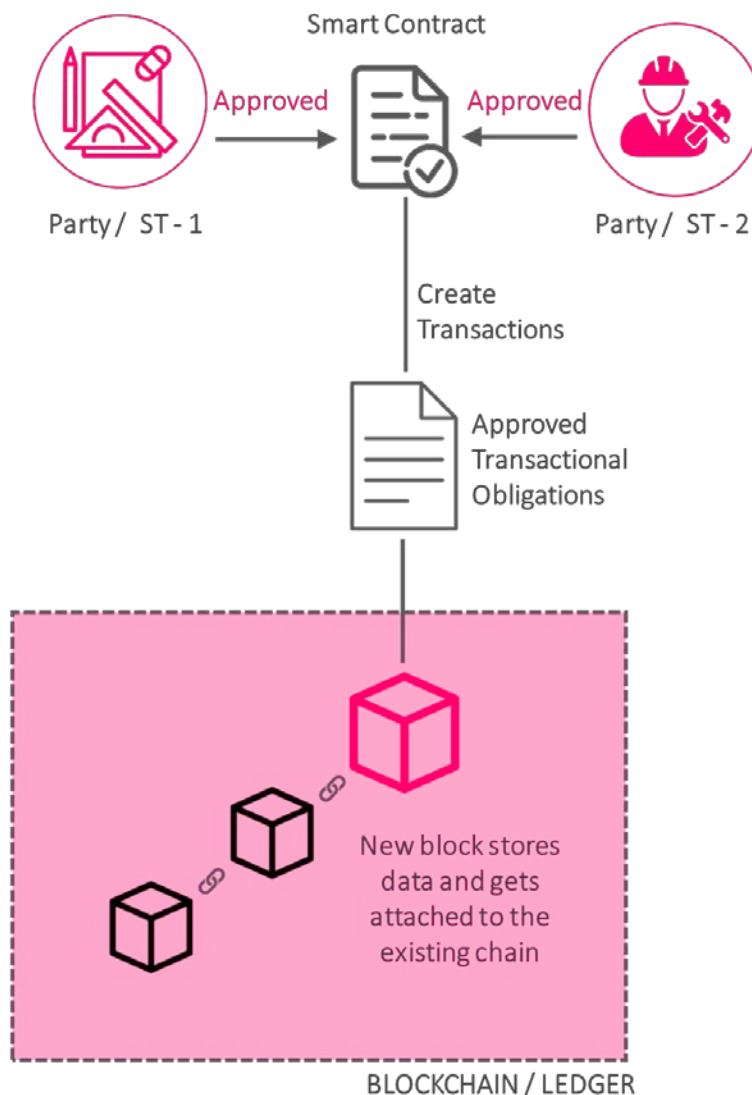


Fig 4.19 Blockchain and Smart Contract – Flow Diagram

The cases for use of smart contracts vary between simple and difficult. In fundamental economic transactions they may be used to transfer money from point A to point B. Smart contracts can also be used to register certain types of ownership or property rights as well as to monitor Smart Access in the Decentralized Economy, such as land records and intellectual property. Smart contracts will threaten many companies. Cases have been used in the banking, insurance, energy, e-government, telecommunications, culture, art, mobility, education etc. A digital record and a signature that is definable, validated, stored, and traded for smart contracts should be provided for every arrangement, process, assignment and payment. Smart contracts may also be used to regulate a range of people who share the same interests and objectives in the supply chain of goods or services, or to govern groups of individuals who share the same interests and objectives without the need for traditional structured systems for far more complex interactions between several players. DAOs are an example of this and they are perhaps the most complex smart contracts. The smart contract formalizes the values of government of an organization, including its statutes, regulations, protocol or articles of integration, and supersedes the day-to-day corporate management with the code of self-implementation.

4.1.7 Smart Contract – Operation

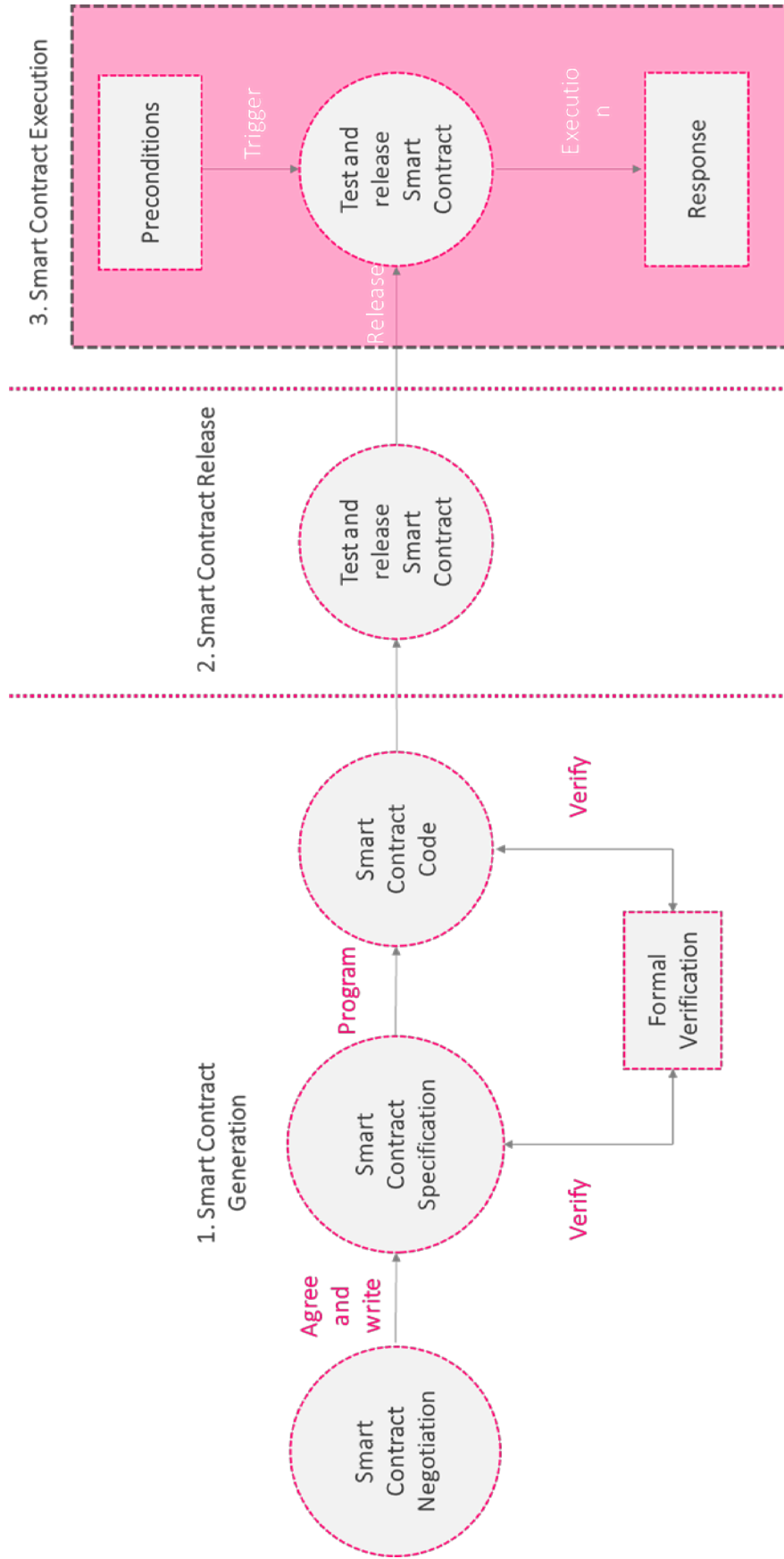


Fig 4.20 Smart Contract – Operation

4.1.8 Blockchain and Smart contract - Transaction and Storage process

- **Step – 1:** The two partners A and B shall facilitate an exchange.
- **Step – 2:** This transaction is then created as a Smart Contract and spread to the entire network before clarification is given.
- **Step – 3:** The sender/receiver is suitable and the same exchange has not been initiated twice during the validation process. Amongst other things. If the network is agreed, the authentication is finished and hashed data for a transaction is contained in the "bar," which provides a manipulative record.
- **Step – 4:** Then the newest block upgrades to the Blockchain.
- **Step – 5:** When the exchange is completed, the transmitted crypto object, data or requests, etc., is stored on the block to be added as an archive for possible references to an existing blockchain.

There is no centralized third party or an accountant in this phase who can improve the ledger without consent or validation from the network. Therefore, the Stakeholders of that network must be approved and voted upon for any changes or new transactions.

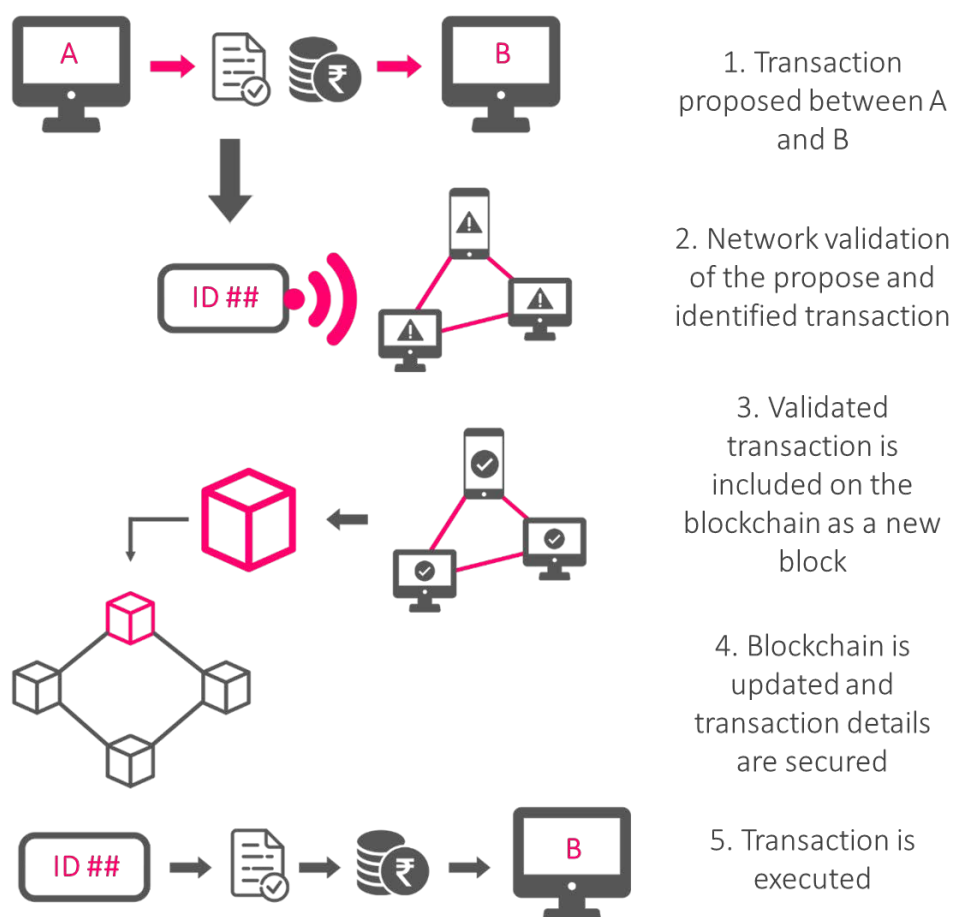


Fig 4.21 Transaction and Storage process

4.1.9 Transaction done using a Third party blockchain operator a System Model

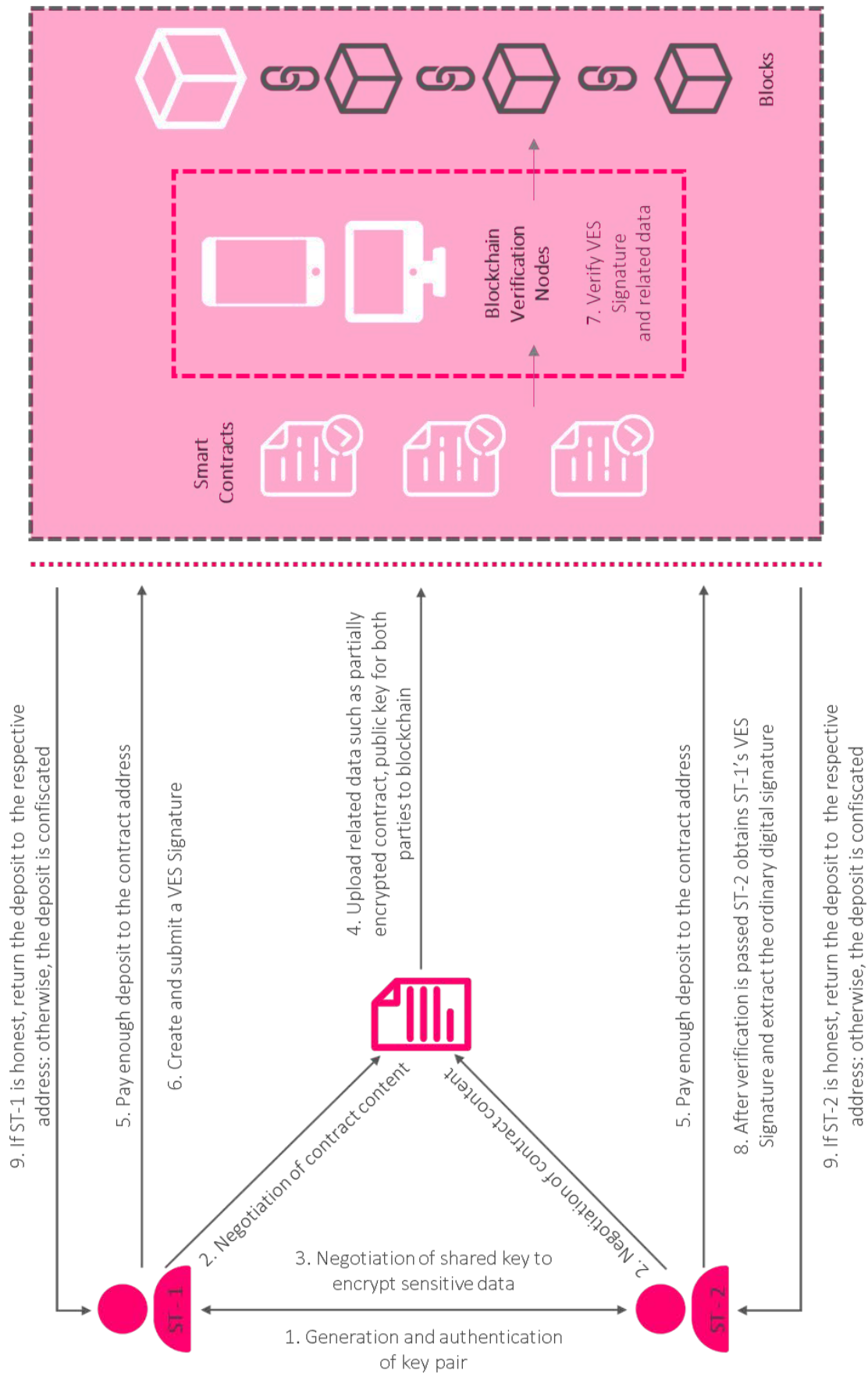


Fig 4.22 System Model

First, the client and Contractor generate their own signature key pair for blockchain. At the same time, to protect the sensitive information in the contract, both signing parties have to use a shared encryption key **K** to execute encryption operations for the sensitive information in the contract. Then the related data, such as the public key of both signing parties, the encrypted contract, will be uploaded to the blockchain by the smart contract. After checking the data on the blockchain, the client and Contractor need to make sufficient deposits to the smart contract account before the specific time. Next, after both signing parties make the deposits, the client and Contractor create their **VES** respectively off-blockchain. Then they submit their own **VES** and the related data to the blockchain by the smart contract. Now suppose the client's **VES** verification passes, Contractor will obtain the client's **VES** and extract the ordinary signature from the client's **VES** by using his private key. Last, if both signing parties submit the valid **VESe**s before a specified time, the contract is signed successfully. The deposits paid by both parties will be returned to their addresses. Otherwise, an overtime penalty mechanism and a credit mechanism will be triggered to punish the dishonest party.

4.1.10 Blockchain enabled project collaboration

Here we will see how cooperation with such technologies is improved in a Design Joint Venture (DJV). During the project planning phase, the different design packages and deliverables are defined by software. The underlying blockchain network has similar thresholds and bundles, along with smart contracts ready for transactions depending on working hours and deliverables delivered on schedule.

Smart contracts are used to allow these straightforward and faster transactions using the project bank account blockchain framework. Payment remains in conventional fiat currency, but is now initiated by a smart blockchain contract.

The platform helps to collect and document all the related activities within the DJV and/or within project partners at the start of the design procedure. The forum does not disclose the distinct concept packages or measurements, but the phases of digital signatures, permits and quality assurance (QA). In order to update the project progress data automatic, smart contracts are required to use these inputs and implementation approves are guaranteed for their responsibilities and traceability, since it is a flawless system. In addition, the parties on the blockchain shall monitor and share all relevant working hours to avoid the need for unnecessary bureaucracy that requires time and resources. Smart contracts handle this logistical information and update the blockchain ledger to alert all.

Table 4.1 Blockchain enabled designing and project collaboration

	Project Planning	Design and QA	Delivery	Project Progress
Project Team	Defined team, program, design packages, deliverables.	Scheme design, detailed design, revisions and design decisions.	Submissions, milestones, delivery completion and approvals.	Progress monitoring and KPIs, program modifications.
Blockchain Platform	Contractual terms included, milestones, delivery packages are added and included in smart contracts	Communication, design interactions, QA procedures, approvals, design and delivery packages	Design submissions, changes, modifications, Worked hours/delivery, additional work claims	KPI checking, reporting and updating. Delivery status check and follow up. Cost/ budget/ time monitoring
Output	– Smart Contract to register hours – no admin overhead – Automatic payment – Deliverables according to contracts/agreements	– Quality procedures are followed and – Interactions within the whole team are transparent – Enhanced accountable collaboration	– Design approvals are transparent – Automatic payments according to work registered, delivered	– Real time KPI monitoring – Continuous project updates – Delivery follow up and schedule monitoring – Automated administration

4.1.11 Design package submission through smart contract

The document management system notifies the smart contract, when a proposal is over, that a design kit has been sent to it. The necessary parties are then instructed to verify the document, and the document can be signed, as the ID with their trusted digital signature is already stored on a blockchain. As all transactions are registered on the same blockchain network, smart contracts are suitable for transferring and updating project achievement measurements.

The advantages of creating such a collaborative structure would strengthen the project management and reporting. It would help to reduce the misalignment of contracts and enforce collective corrective mechanisms in the joint venture. Through using traceable data on the blockchain for progress monitoring, the accuracy of expense and timetable predictions can be significantly boost.

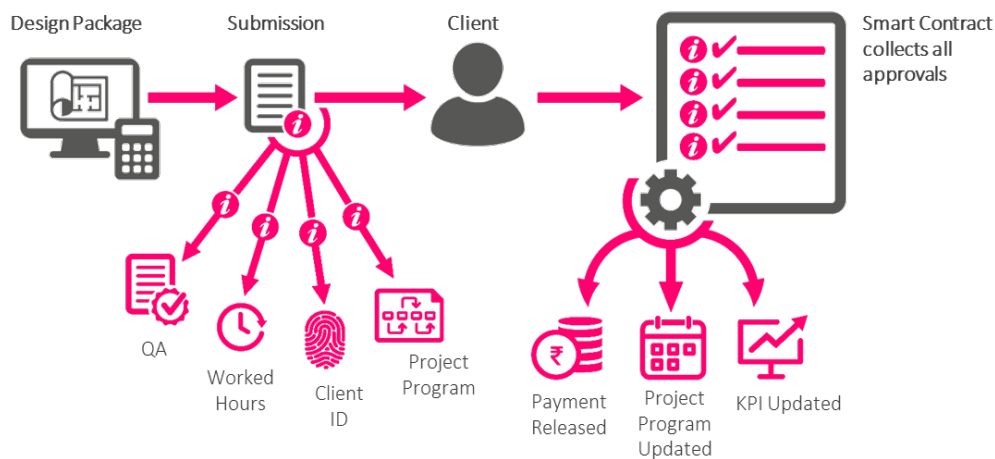


Fig 4.23 Design package submission through smart contract

4.1.12 Streamlined procurement and smart contract payment

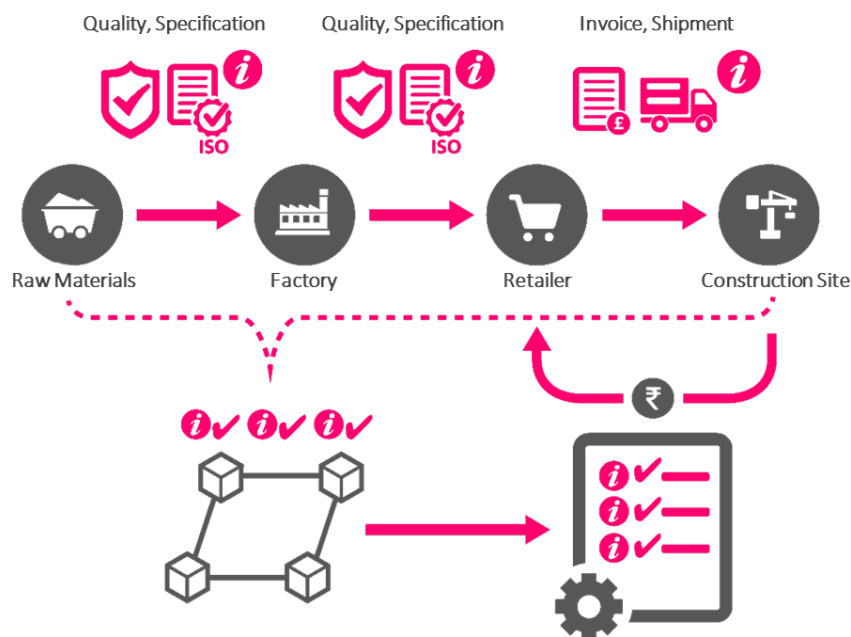
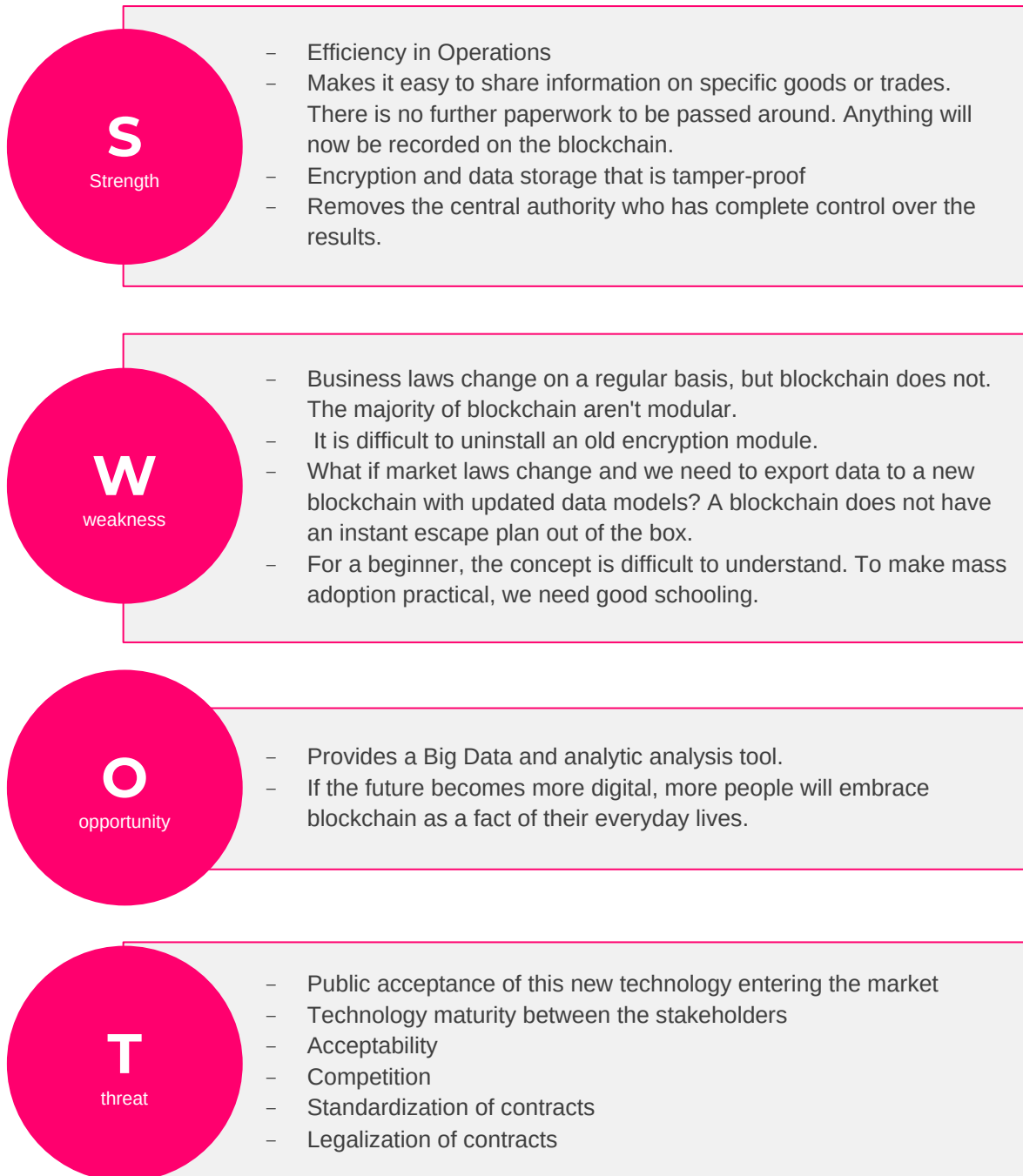


Fig 4.24 Streamlined procurement and smart contract payment

Smart contracts can automatically manage billing and approved transfers as all paper works are handled through the blockchain system. The delivery terms and conditions are fulfilled. A more responsive ecosystem in which all challenges are identified and addressed more easily, reducing risk and overall uncertainty would result in consistent documents and supply chain management permitted by this blockchain solution.

4.1.13 SWOT - Analysis



4.1.14 Recommendations



Predictive Maintenance

Long-term maintenance and restoration was made easier with a clear ledger of a building's finances



Smarter Contracts

Contract milestones enforce the scale of a project while also structuring its movement



24/7 Collaboration

With immediate access to project data, every group will have feedback for others to see



Streamlined Supply Chains

In a distributed ledger of projects and payments, you can verify vendors and contractor faster



Accelerated Payments

Payment plans are enforced by smart contracts, which eliminate processing costs



Proactive Oversight

For third parties in charge of supervision, adhering to regulations is easy

4.1.15 Conclusion

Our industry is undergoing a transformation. This transition is partly digital, to increase productivity and digital workflows, and partly a revolution of management practices, since the existing hierarchy-based status quo paradigm is unsustainable. Blockchain technology has the ability to influence and promote both reforms and innovation.

This study showed how the existing payment, project management structure, contract management, procurement and supply chain management can be shifted to a more open and equitable system. Small and medium businesses are no longer exposed to constant cash flow pressure by reducing late fees, standardizations, and conflicts. Instead, the industry as a whole can improve its reputation.

Business organizations and routine functions can be automated with smart contracts to improve reliability and ensure that they are still in line with the contractual terms. This will lead to considerable cost cuts, an increase in the industry's poor profits, and greater project cost management.

The use of blockchain technology will help to streamline the procurement process, reducing the fragmentation and sophistication of large projects. The provenance of goods will help mitigate waste and improve product

and service efficiency while maintaining high transparency. Such programs can improve predictability not only in terms of acquisition, but also in terms of project execution as a whole.

Yet Smart contracts pose their own set of legal challenges like

- **Is it possible to get legal recognition for smart contracts?**
- **Are they enforceable in the same way as conventional contracts are?**
- **Is it possible to conduct a smart contract between two (or more) parties whose names are unknown to each other?**
- **Will human analysis be allowed given the highly existence of smart contracts to avoid absurd outcomes?**
- **Who is responsible in the event of a leak or hack?**

And for our industry bringing together all the stakeholders with the help of our government will be much more reasonable and even the government itself can take initiative in developing such kinds of technologies and to maintain them for a longer run it is better to have teams coordinating for each activities like a Professional accountant – to maintain and over view the accounts and transactions, Auditor and Lawyer team to maintain and overview all the legal clauses, Taxations and GST's, etc.

While the technology is new and there are a few early hurdles to overcome, the opportunity to reshape the industry for the better is simply too big to ignore. Construction is one of the world's largest sectors, and the infrastructure it builds is critical to economic development and productivity. It is our inherent duty to assist in the digital transformation in order for it to be prepared for the challenges of the twenty-first century

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