
UNIT 5 APPLICATIONS OF BLOCKCHAIN TECHNOLOGY

Structure

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5.1 INTRODUCTION

The first and the most popular application of Blockchain Technology was cryptocurrency. But now, blockchain is no longer confined to cryptocurrencies. The features of blockchain such as enhanced security, privacy, traceability, inherent data provenance and time-stamping have made blockchain a backbone for various industries in a minimal period of a decade only. The applications of blockchain technology have enveloped areas ranging from financial services, education and healthcare to real estate, insurance and energy. Wherever there are intermediaries, industries will prefer blockchain technology to bring security, transparency, and win customers, investors, and other stakeholders. That is why blockchain has made inroads in various industries/sectors. Financial sectors were early to realise the potential of blockchain technology. The healthcare industry implemented blockchain in electronic health records to make it more efficient, trustworthy, and effective to make available information helpful in better care of patients. The real estate sector has a lot of intermediaries, and information is difficult to get verified; a smart contract, simply speaking a digital contract, can bring a lot of transparency and ensure the immutability of records. Energy trading in the energy sector is getting benefitted from blockchain technology. Thus blockchain technology brings many potential applications for various industries/sectors, and these potentials are getting translated into business cases by both startups and established corporates/business houses.

Objectives:

In this unit, you will learn about the applications of blockchain technology in various sectors and industries. After reading this unit, you will be able to:

- Appreciate applications of blockchain technology in the financial sector
- Understand applications of blockchain technology in the education sector
- Identify key applications of blockchain in healthcare
- Understand the applications of blockchain in the insurance sector
- Discuss various applications of blockchain in real estate and
- Appreciate applications of blockchain in the energy sector

5.2 FINANCIAL SERVICES

Internet banking and IT technologies have been introduced in the financial sectors, but still, it is predominantly paper-based. So financial sector based on internet banking and IT technologies may be considered semiautomatic. There are several powerful intermediaries in the financial sectors slowing the system. Trust is of prime significance in the financial sector. Trust and decentralisation are the main characteristics of blockchain technology. Blockchain technology has the potential to make inroads in not only payments but also in investment banking, venture capital, the securities industry, retail banking and many more. Blockchain can provide a robust solution for authenticating identity or KYC (Know Your Customer). Many intermediaries play their roles in making payments, transferring money, and purchasing goods and services, making the process slow and tardy. Blockchain can eliminate these intermediaries and make the payment system more transparent, secure and fast. Thus blockchain has various applications in financial sectors. Some of the applications have been discussed here.

5.2.1 Application of Blockchain in Trade Finance

Trade finance is the financing of international trade flows. It exists to reduce the risks involved in an international trade transaction. An exporter (seller) requires an importer (buyer) to prepay for goods shipped. The importer (buyer) may want to reduce risk by asking the exporter (seller) for documents that the goods have been shipped. The importer's bank assists by providing a letter of credit (LC) to the exporter (or the exporter's bank), providing for payment upon presentation of certain documents.

Banks on both sides of transactions (exporter and importer) play a key role in financing international trade. Following are some popular methods of financing international trade (also known as financial instruments).

- Factoring
- Letters of Credit (LCs)

Factoring

When an exporter ships goods before receiving payment, the accounts receivable balance increases. Since there is a danger that the importer will never pay at all, the exporting firm may consider selling the accounts receivable to a third party. This third party is known as a Factor. The Factor assumes all administrative responsibilities involved in collecting from the importer and the associated credit exposure. Now Factor has to check the creditworthiness of the importer. This consists of a network of Factors in various countries to assess credit risk. Here interaction is among exporter, importer, and factor.

Now smart contracts in an agreed format, based on accounting documents and invoices etc., may be introduced using a blockchain network. A hash will be generated using the algorithm for the delivery of goods based on key fields. The smart contract records the hash of the delivery, all amounts, date of posting of amounts. If the hashes match, it is confirmation of delivery of goods. After this, the factor pays the exporter the amount mentioned in the documents. The whole process is as shown in Figure 5.1.

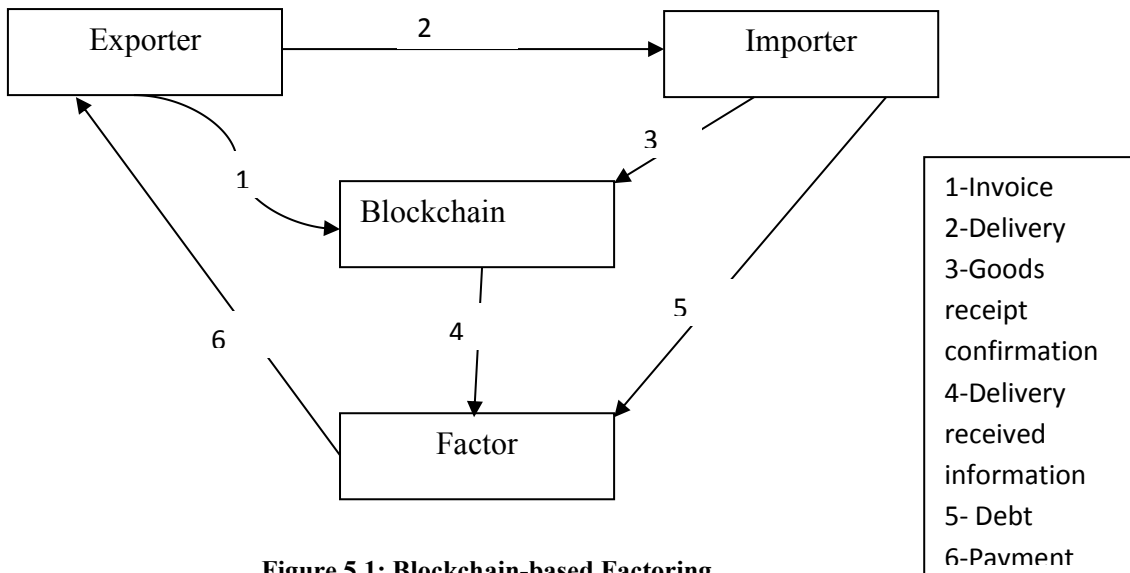


Figure 5.1: Blockchain-based Factoring

Letters of Credit

A letter of credit (LC) is an instrument issued by a bank on behalf of the importer promising to pay the exporter upon presentation of shipping documents in compliance with the terms stipulated therein. In other words, LC is an undertaking by a bank to make payment on behalf of the importer to the exporter under specified conditions. The exporter is paid upon presentation of the required documents in compliance with the terms of the LC. The LC process involves the exporter's bank (Correspondent Bank) and the importer's bank (Issuing bank).

Traditional Model of Trade Finance with LC

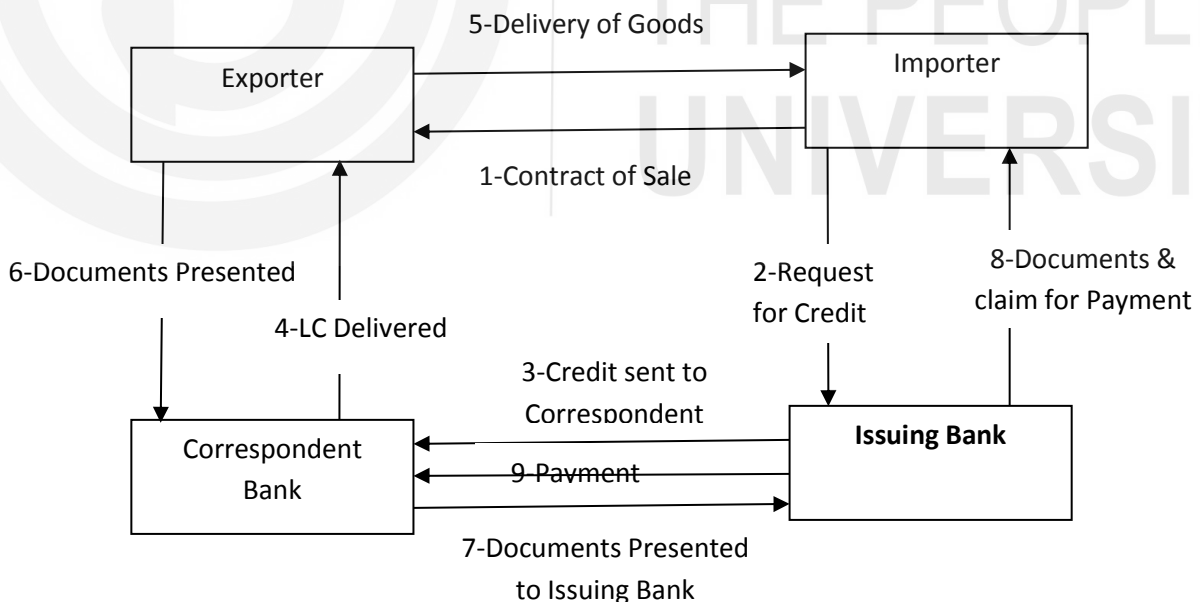


Figure 5.2: Traditional Model of Trade Finance with LC

Model of Trade Finance with LC with Blockchain

Blockchain model in trade finance with a LC with blockchain will increase the effectiveness of processes involved. The introduction of a smart contract will make the whole process more effective. As shown in Figure 5.3, the model of trade finance with a LC with blockchain. The process of execution of a smart contract has been delineated here. The importer writes an application for opening digital LC specifying exporter's details, terms of contract (value of

export, i.e. amount, period etc.) and other required characteristics. Then the issuing bank opens a digital LC. The information is added to the block, and the information is visible to participants. When the exporter sends information of delivery of goods to correspondent bank, the correspondent bank transfers the amount to the exporter and executes a digital LC. The idea here is to optimize the processes.

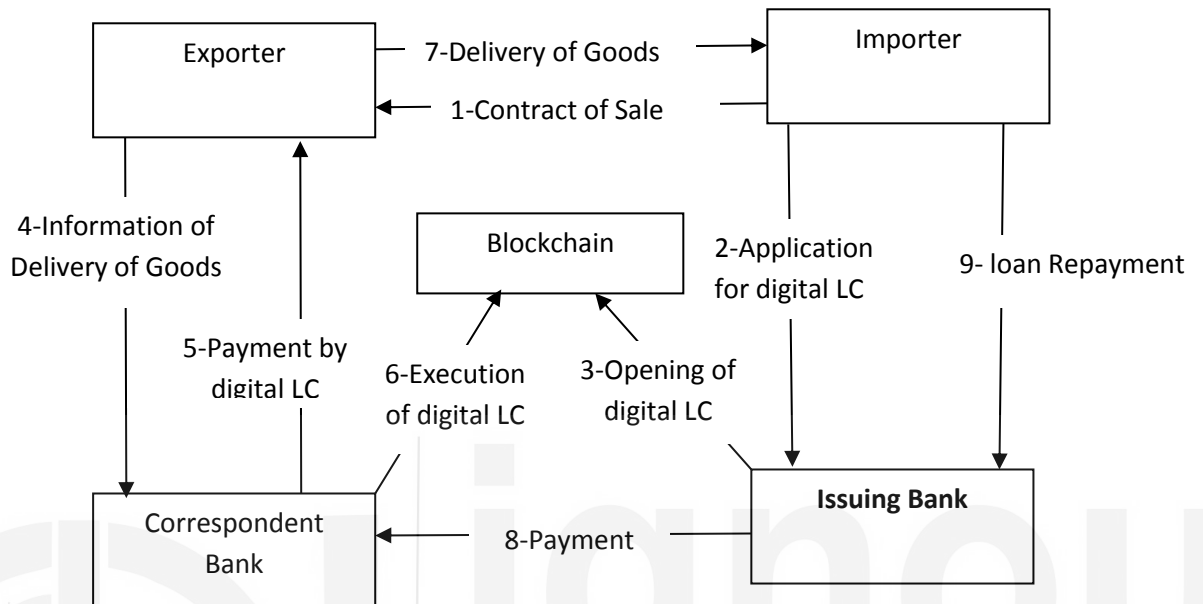


Figure 5.3: Model of Trade Finance with LC with Blockchain Application

5.2.2 Application of Blockchain in Crowdfunding

The fruition of a business idea into reality needs funds. Crowdfunding is internet-enabled ways for startups to raise funds in the form of investments from various individuals. Crowdfunding is an alternative to traditional banking. Recently fundraising through crowdfunding has become very common. It is important to ensure that the fund raised is not used for illegal businesses and the interest of stakeholders are secured. Further, the rights of investors must be clearly spelled out. So the necessity is to create a safe, secure and fraud-proof system for startups to raise funds and investors to provide funds. Blockchain technology through a smart contract can build trust between fundraisers and fund providers.

The traditional model of crowdfunding has been shown in Figure 5.4. Crowdfunding involves three types of stakeholders or parties. These are: fundraisers, funders and institutions. Fundraisers may be startups seeking funds for their business venture or viable business ideas. Institutions work as mediators for fundraisers who seek capital for the fruition of their ventures. Funders or investors are individuals willing to contribute funds to the fundraisers in exchange for part ownership of the company in the form of share or interest plus principal in the future or any other contract signed between fundraisers and funders. Technology via the internet is the means by which fundraisers reach the funders or investors and also receive funds.

The blockchain-based model of crowdfunding is as shown in Figure 5.5. The use of blockchain technology in crowdfunding will overcome many challenges faced by the traditional method of crowdfunding. Blockchain technology will help record information related to business registration and keep a record of the nature of business. Funders or investors can access this information very easily. Contracts between fundraisers and funders using smart contract will bring transparency and protection for funders and keep away fundraisers from

unnecessary pressure of funders. In the blockchain based model of crowdfunding, technology is secure and trusted machine. Thereby this model will provide a secure and safe environment for all concerned parties or stakeholders.

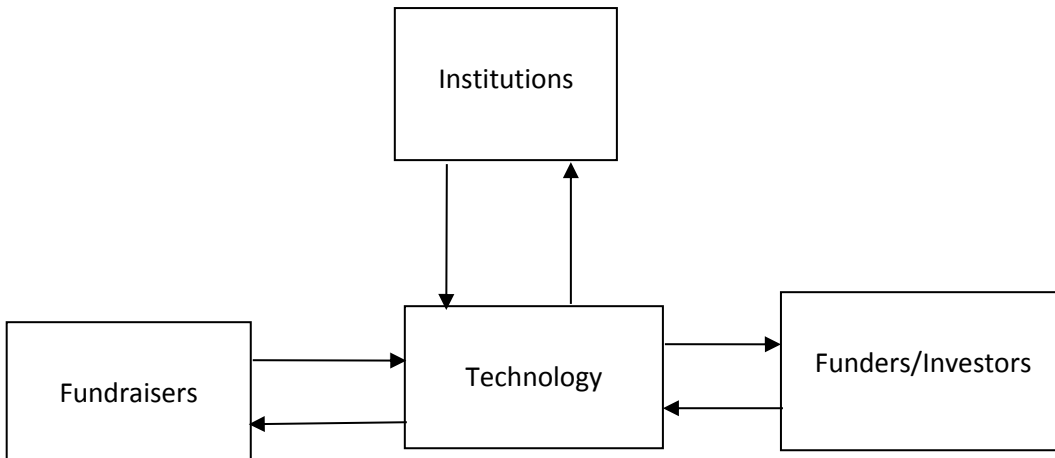


Figure 5.4: Traditional Model of Crowdfunding

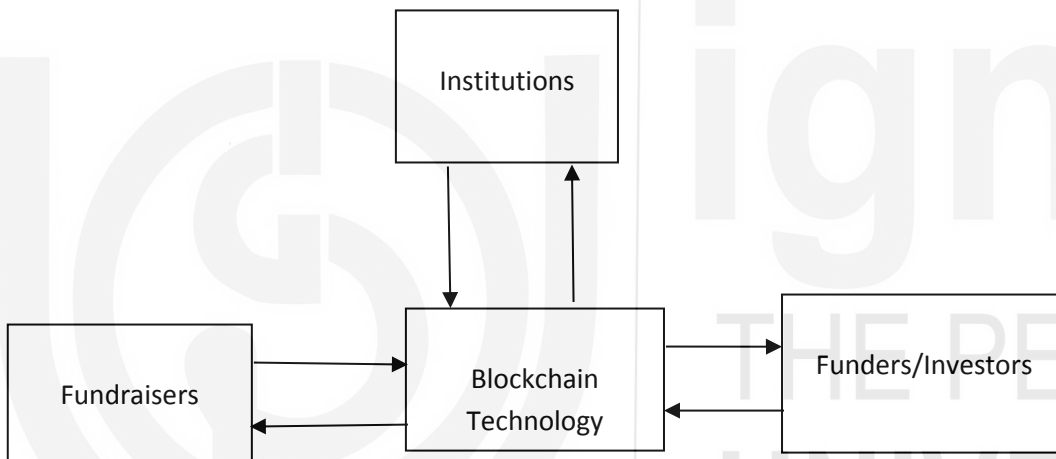


Figure 5.5: Blockchain-based Model of Crowdfunding

Check Your Progress 1

In this section, you studied applications of blockchain in financial services, now answer the questions given in Check Your Progress-1.

Note: a) Write your answer in about 50 words

b) Check your answer with possible answers given at the end of the unit

(1) Discuss Factoring.

(2) What is a Letter of Credit (LC)? Discuss a model of trade finance with LC with blockchain.

(3) What is crowdfunding? How will blockchain bring transparency and security to crowdfunding?

5.3 EDUCATION

Currently, educational institutions and administrative bodies are controlling the education sector. There is no doubt that the existing traditional models are providing quality, credibility and knowledge. But the main constraint is flexibility. There is a lack of flexibility in terms of time and money. Further, the challenges faced by traditional education systems are: record-keeping, badges, on the job training etc. The solution to these challenges lies in using blockchain technology for the education system.

Decentralization, trustworthiness and security are the main features of blockchain technology. Blockchain based platforms like Ethereum and Hyperledger Fabric can use smart contracts. Many applications of blockchain in the education sector can be based on smart contracts.

5.3.1 Applications of Blockchain in Education

There are many blockchain-based applications for educational institutions. The first and the foremost is the certificate/degree verification. Other blockchain-based applications are: fees and credit transfer, learning outcomes management, online learning environment, and evaluation of students' professional ability. A few applications have been dealt with here.

Certificates Management

When you enroll for a course, degree, diploma or any course, you get a certificate after successfully completing the course. In a way, certificate confirms the achievement of specific learning outcomes. Thus certificate has a very important role in education. Companies/Employers hiring a candidate verify student's certificate before employing. Traditionally, educational institutions, universities, institutes, issue paper-based certificates. Paper-based certificates have various benefits. For example, a student can easily keep it, and present certificate whenever asked for any purpose like job, admission etc. But verification of certificate by the third party, like an employer, needs extra effort as the third party will have to contact the certificate issuing authority.

Blockchain technology can support this transition from paper certificates to digital certificates, with all security features. As you know, transactions in blockchain technology are decentralized, secure, transparent and immutable. And hence, the transition from a paper certificate to a digital certificate will be secure and safe using blockchain technology.

A few educational platforms that are meant for sharing and verifying educational certificates based on blockchain technology are listed below:

- **Blockcerts:** Blockcerts, developed by MIT media lab, is an open-source platform for creating, sharing and verifying educational certificates.
- **TrueRec:** TrueRec, developed by SAP, is based on the Ethereum platform of blockchain. It stores professional and academic credentials, like university degrees and employment certificates

Many universities are using blockchain technology to issue and store degrees and diplomas. Some of these are: MIT, Woolf University, Universities in Dubai.

The architecture of blockchain technology in education is as shown in Figure 5.6. This architecture shows an ecosystem of Ethereum blockchain, university, student and employer. The university issues degree to a student using the hashed certificate and adds it to the Ethereum blockchain. An employer who has access to this blockchain searches and verifies a student’s degree.

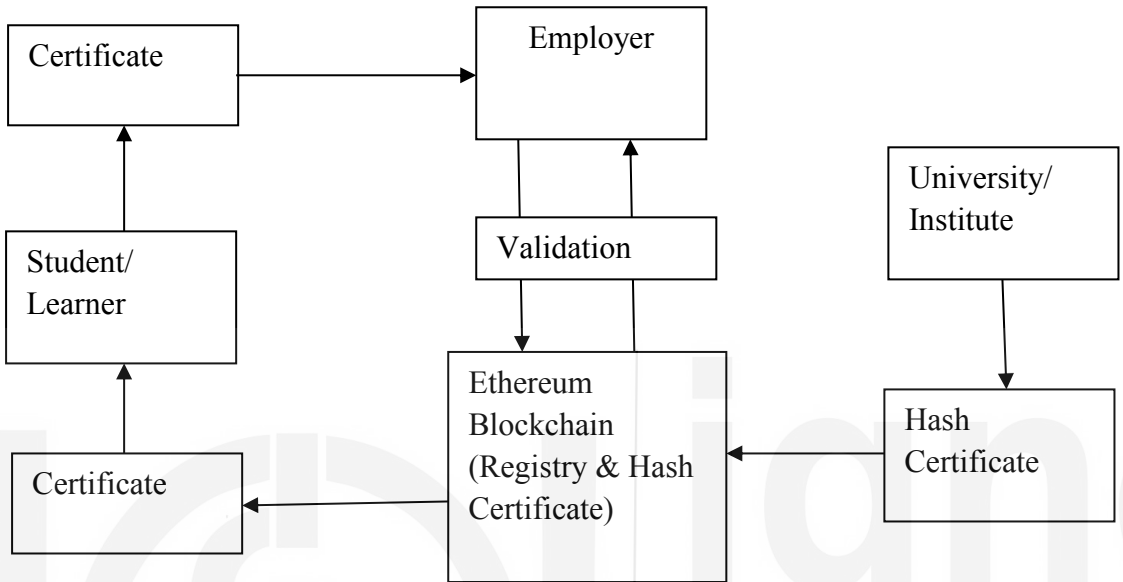


Figure 5.6: Architecture of the Blockchain for Education

Fees and Credit Transfer

Educational institutions depend on a third party or intermediary when it comes to credit transfer of a certain completed portion of the course among educational institutions or transfer of fees. Wherever there is a third party or intermediary, blockchain plays a very effective and efficient role. EduCTX platform, based on Ethereum, enables the transfer process using tokens. These tokens can be any digital form of learning – courses, certificates or degrees.

5.3.2 Benefits of Blockchain Technology in Education Sector

Following are the benefits of blockchain technology in the education sector:

- Security
- Better Control in Accessing Students’ Data
- Accountability and Transparency
- Trust
- Lowering the Cost
- Authentication

5.3.3 Challenges of Blockchain Technology in Education

There are a lot of potential applications of blockchain technology in the education sector. But there are associated challenges too that need to be addressed. These challenges are in terms of scalability, adoption cost, trust, immutability, to name a few. These challenges have been spelled out here.

Scalability

With the increase of transactions in the blockchain network, blocks’ size will increase. This will cause latency in transactions. The slow speed of blockchain

transactions is a major problem that educational institutions will have to face while using blockchain. However, new scaling methods are likely to address this problem.

Cost of Adopting Blockchain Technology

Blockchain is an emerging technology. This technology will have to be integrated with the legacy system, i.e., the existing system. The cost of adoption and implementation may be very high.

Trust

The major concern may be the reluctance of educational institutions to share data on the blockchain network. As of now, there is insufficient evidence on business gains for educational institutions in using blockchain technology.

Immutability

Immutability is an important characteristic of blockchain technology. Immutability brings more trust to all concerned parties. Once students' achievements are integrated into a blockchain, any party cannot alter them. However, the immutability feature would act as a double-edged sword. It removes the possibility of modifying records for legitimate reasons for some students.

Check Your Progress 2

In this section, you studied applications of blockchain technology in the education sector, now answer the questions given in Check Your Progress-2.

Note: a) Write your answer in about 50 words

b) Check your answer with possible answers given at the end of the unit

(1) What are blockchain-based applications in the education sector?

(2) What are the benefits of blockchain in the education field?

(3) Discuss the challenges of blockchain technology in education.

5.4 HEALTHCARE

What are the requirements of the healthcare industry? The answer is: security, interoperability, data sharing and data access. Blockchain features include security, assurance, immutability, authentication, decentralized storage, data sharing, and data access. The requirement of the healthcare industry and features of blockchain map each other. That is why the potential of blockchain technology in the healthcare industry is immense. And these potential applications are being implemented by various startups and established players.

5.4.1 Applications of Blockchain in Healthcare

Applications of blockchain technology in the healthcare industry:

- E-Health Record System
- Medical fraud detection system
- Clinical research
- Pharmaceutical industry research
- Neuroscience

Some of these applications of blockchain technology in healthcare are discussed here to appreciate these.

E-Health Record System

The health record system can be seen in three phases. These are: Paper-based health records, Electronic health records and Electronic health records using blockchain technology. The paper-based health record system was inefficient, unorganized, and insecure and was not tamper-proof. Electronic health records (EHR) is a combination of paper-based medical records and electronic medical records. EHR system is efficient and cost-effective as compared to paper-based medical records. The features of EHR are: electronic storage of medical records, patient's appointment management, billings and accounts and lab tests. But EHR faced certain problems such as interoperability, information asymmetry and data breach. Interoperability is the process of sharing and transferring data among various sources. As the medical data is centralized in various institutions, and not in a standardized format, interoperability is lacking. Further medical data and records are generally accessible to doctors and hospitals, and patients cannot access these data easily. This results in information asymmetry. Apart from that, there are numerous instances of medical records being the target of cyber-attacks. These problems of interoperability, information asymmetry and data breach can be addressed by using blockchain technology. A simple EHR system based on blockchain works in the following way:

- Large medical data are collected from patients through mobile applications and EHR system
- Collected data are encrypted and stored in the blockchain network
- The encrypted health advice relayed back to patients individually

MeDRec, MeDShare etc. are prototypes of blockchain-based EHR (brief introduction in 5.4.2). Estonian medical record based on blockchain is worth mentioning. This blockchain-based EHR system allows Estonian citizens, healthcare providers, and health insurance companies to retrieve all medical treatments performed in Estonia by using the technology.

Medical Fraud Detection System

Drug safety is an important concern as it directly affects public health. So supply chain management in the medical field is an important task. Otherwise, it would be difficult to control counterfeit drug production, fake package recordings and changing labels for polluted drugs in its circulation. Further supply chain of healthcare involves many moving peoples and parts making it vulnerable for fraudulent attacks. The application of blockchain enables a smart tracking and tracing platform

Clinical Research

Trust is always a question in medical research as data can be manipulated. So, clinical trials must test the effectiveness of new drugs and their side effects. There are four phases in clinical trials. These are: examination of new drug's safety, examination of safety along with effectiveness on people, the study of drug dose efficacy and patient safety and long term effectiveness of the new

drug. Due to various errors like fraud, data mismanagement and trial misconduct, nearly 80% of medical studies are non-reproducible. Transparency at various stages of clinical trials can be ensured using blockchain technology. Blockchain technology provides a decentralized data tracking system that reinforces trust between different stakeholders involved in clinical trials. Apart from that, it ensures transparency between patients and physicians.

5.4.2 Software Solution with Application of Blockchain in Healthcare

To highlight the potential applications of blockchain technology, some existing solutions in the areas of Electronic Health Record, Patient Health Record of the healthcare industry based on blockchain technology have been discussed here.

Gem Health Network

When a person travels (another state or overseas) and becomes sick, he can't contact his local doctor to retrieve the medical record. Gem Health Network has come with a potential solution for such cases. Gem Health Network uses the Ethereum blockchain technology to create shared network infrastructure. The Gem Health Network allows different healthcare professionals to access the same healthcare information, removing the limitations of centralized storage. The medical records and information are relevant, transparent, and authorized users have real-time access to the latest treatment information.

OmniPHR

OmniPHR is a model based on blockchain architecture to help handle patient health records. OmniPHR gives patients a unified view of their health records stored across multiple healthcare providers. Further, the OmniPHR framework promotes interoperability among different healthcare providers to access healthcare records.

MedRec

MedRec, developed by Azaria, Ekblaw, Vieira, and Lippman, is a decentralized record management system to handle Electronic Medical Records (EMRs) using blockchain technology. The system allows patients real-time access to their medical information across multiple medical providers and treatment locations. MedRec is built on Ethereum blockchain. MedRec defines three types of smart contracts: a registrar contract, summary contract, and patient provider relationship contract that helps identify the patient, hold the patient's information and compile any relationships the patient may have.

MeDShare

MedShare focuses on secure data sharing among different stakeholders in healthcare. MeDShare uses blockchain technology with cloud services for keeping medical data safe and secure. MeDShare uses a smart contract and access control mechanism to track the data and revoke access to any malicious entity.

Check Your Progress 3

In this section, you studied applications of blockchain technology in the healthcare sector, now answer the questions given in Check Your Progress-3.

Note: a) Write your answer in about 50 words

b) Check your answer with possible answers given at the end of the unit

(1) What is an electronic health record? Discuss a simple electronic health record system model based on blockchain.

(2) Discuss the medical fraud detection system.

(3) Discuss a few software solutions of applications of blockchain in the healthcare industry.

5.5 INSURANCE

Insurance companies compensate clients or policyholders, as per policy, in case of any loss in lieu of a small premium paid by the client or policyholder. The global insurance market is substantial. There are various types of insurance policies for life insurance, health and property and casualty. Life insurance accounts for 46% of the total premium, whereas health insurance accounts for 23% of the total premium globally. The settlement of claims is not very smooth as far as the insurance industry is concerned. The traditional contract method is not foolproof. There is a lack of transparency, and there are certain loopholes. Both the policyholders and insurance companies feel exploited. Smart contracts on blockchain can substantially address these problems by bringing transparency and trust.

5.5.1 Model of Insurance using Blockchain

In a simple insurance model, there are two entities. One is 'Client' and the other 'Agent'. The 'Client' is one who is covered by insurance. The client may request the following processes:

- Registration
- Policy assignment
- Paying premium
- Submitting claim
- Processing refund

The 'Agent' acts on behalf of the 'Client' and processes 'Client's' request on blockchain network.

The execution of each transaction and result is maintained by blockchain. The rules of transactions are governed by a smart contract. Each smart contract consists of verification logic specifying conditions under which transaction has to be executed by a smart contract. The smart contract is for all processes or transactions beginning with the registration to issue of policy, premium payment, claim and refund. A simple model of insurance with blockchain is as shown in Figure 5.7.

What will be the benefit of introducing a smart contract for all processes and transactions? The smart contract does the following tasks:

- Automatic verification of Clients or policyholders (identity and contract validation)
- Removes intermediaries, i.e. external verification entities established to solve disputes
- Shortens the settlement time

In this way, a smart contract can streamline the claim handling process and minimize fraud claims in the insurance industry. One of the motives for adopting blockchain technology in the insurance industry is to prevent fraudulent claims.

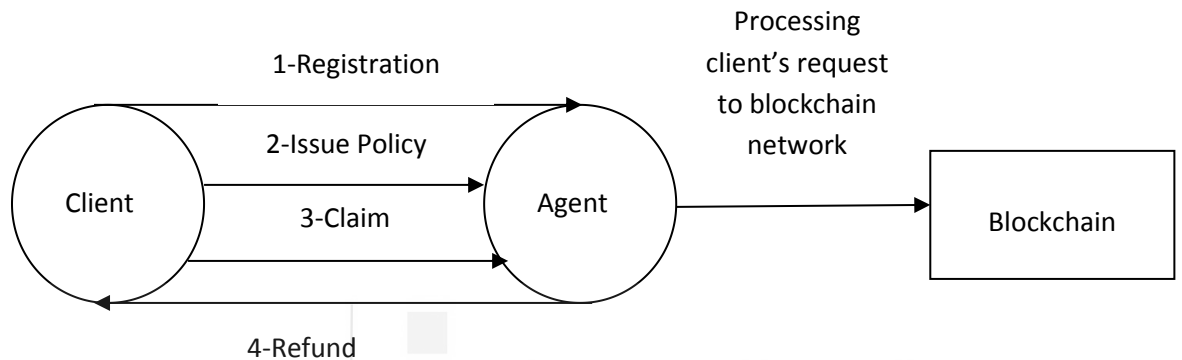


Figure 5.7: Simple Insurance Model with Blockchain

5.5.2 Smart Contract on Blockchain Technology for Insurance

Smart contracts utilizing blockchain technology can expedite claims handling processes resulting in a reduction in administrative and operational costs. Smart contracts may be vividly defined as digitally recorded agreements using protocols that verify and execute the terms of the contract once predefined conditions in the contract are met and substituting human involvement. Some examples based on smart contracts on blockchain technology are discussed here.

Flight Insurance

Several start-ups and established insurance companies have launched flight insurance policies built on a blockchain with smart contracts. AXA, a French insurer, brought a travel insurance product called fizzy. Fizzy is based on blockchain technology. The insurance product for flight travellers is about the delay in flight by more than two hours. The travellers are compensated automatically without manual intervention when a flight is delayed by more than two hours. The policy details are coded in the smart contract. The process of compensation is transparent and much faster as the decision lies with a smart contract.

Marine Insurance

Maersk has partnered with E& Y and Microsoft to build a blockchain-based insurance solution for its fleet of ships. The goal is to make the auditing process of the supply chain easier.

In the future, cars and electronic appliances may have their own insurance policies using smart contracts in a blockchain network. Here damages will be automatically detected, and repair process or compensation will be triggered accordingly.

Check Your Progress 4

In this section, you studied applications of blockchain technology in the insurance sector, now answer the questions given in Check Your Progress-4.

Note: a) Write your answer in about 50 words

b) Check your answer with possible answers given at the end of the unit

(1) Why blockchain technology is required in the insurance sector?

(2) Discuss a simple insurance model with blockchain.

(3) Discuss examples based on a smart contract on blockchain technology in the insurance sector.

5.6 REAL ESTATE

The real estate industry plays a key role in driving a country's economy. At present real estate is a paper-based, time consuming and complex system of ownership. There are too many intermediaries in the real estate sector. Some of the intermediaries to be mentioned are: notaries, attorneys, brokers, agents, appraisers, inspectors, etc. These intermediaries might cause inefficiencies and are likely to increase transaction costs. There is a lack of transparency in transactions like leasing, purchasing and selling. There is a need for transparency in many aspects of real estate operations, such as sale prices, sale history, market valuation, etc. Whenever one goes for real estate investment, sale of property, for leasing or renting, generally there are many misunderstandings among concerned parties. It seems information about the ownership of the property, its market value, any third party dispute, and other information are being concealed. There is an air of suspicion, delusion and mistrust. To get rid of the issues related to transparency, data integrity and security, digitization of property-related information is essential. Further, this digitized information should be available on distributed systems to minimize the incidence of inaccuracies and fraud. Blockchain can play a pivotal role in many aspects of real estate, be it real estate investment decisions or choosing real estate investment properties.

5.6.1 Smart Contract Embedded in Blockchain for the Real Estate

Transaction processes using smart contracts embedded in blockchain for real estate is as shown in Figure 5.8. Here a buyer searches the property through Multi Listing Services (MLS). Multi Listing Services is a centralized database of real estate properties for brokers and agents to facilitate buyers to choose property. MLS is gaining momentum in India also. One of the examples of MLS in India is "Listings of India" (listingsofindia.com) that connects real estate agents in India. But there is a problem with the existing MLS. The information provided through MLS may be inaccurate, outdated or incomplete. This problem can be overcome by the use of blockchain. The introduction of

blockchain will help in data getting distributed across a peer-to-peer network. The registered users will publish data related to a property using a smart contract on blockchain-enabled MLS. The registration will ensure the unique identity of the owner and his/her associated property. Decision to include or exclude the new listing will be based on common consensus mechanism involving all peers. Thus blockchain-based MLS will be more reliable as compared to traditional MLS.

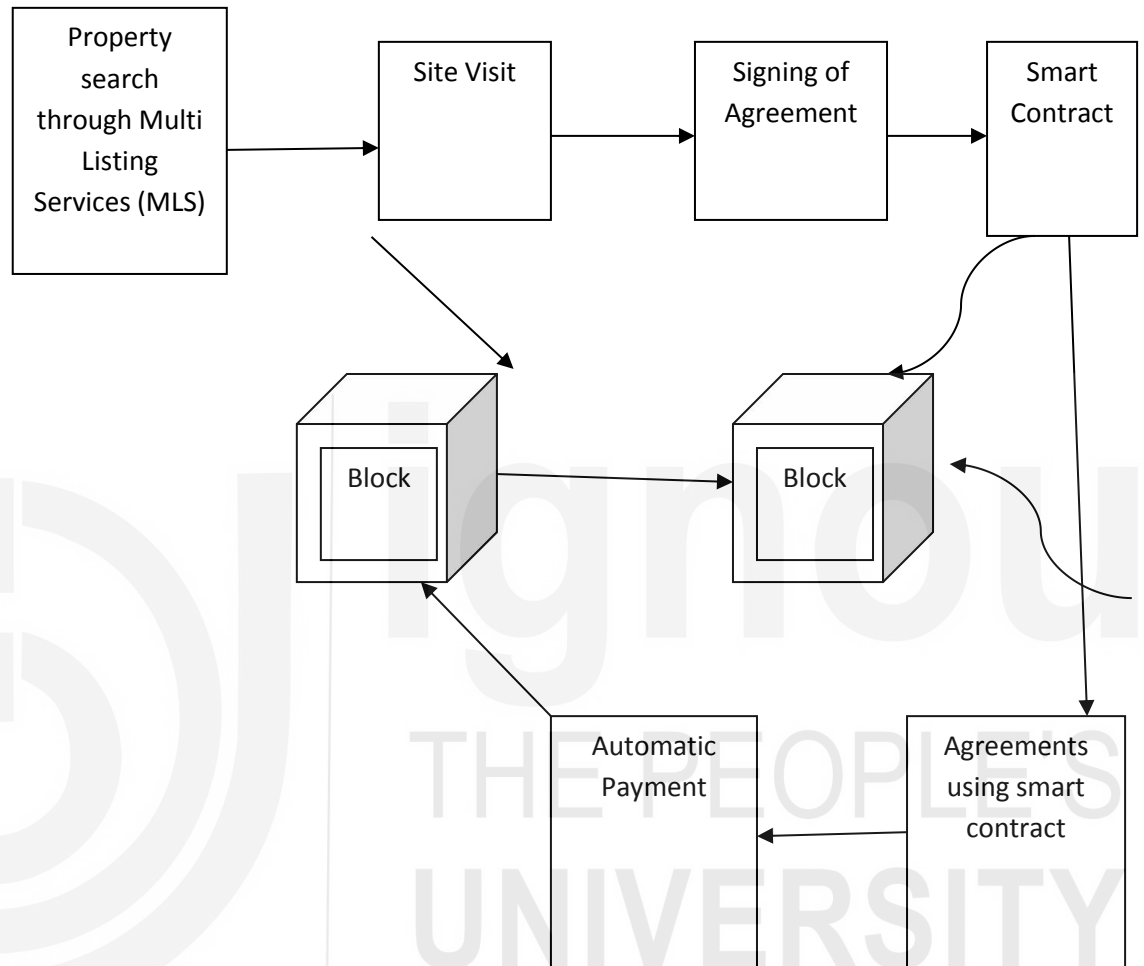


Figure 5.8: Transaction Process using a Blockchain-based System

After searching a property, a buyer can visit the site physically or using virtual reality (VR). A formal agreement is signed between the buyer and the seller. After that, due diligence and background verification will be done by both parties. Manual verification is fraught with many mistrust and inefficiencies. The smart contract will make the whole process transparent and reliable. A general Smart contract for buying a property in the real estate sector should include the following information:

- Owner's address
- Buyer's address
- Purchase Id of the property
- Purchase value of the property
- Buying agreement template
- Purchase payment

A smart contract can be developed in Ethereum using its programming code known as solidity. Solidity is an object-oriented programming language for writing a smart contract. The key terms of the agreement are recorded and

embedded to the blockchain. Then automatic payment is initiated. Finally, the seller transfers the property possession to the buyer after getting payment.

Check Your Progress 5

In this section, you studied applications of blockchain in the real estate sector, now answer the questions given in Check Your Progress-5.

Note: a) Write your answer in about 50 words

b) Check your answer with possible answers given at the end of the unit

(1) Discuss the transaction process using a blockchain-based system for buying a property in the real estate sector.

(2) List a few information contained in the smart contract of real estate.

5.7 ENERGY

The world is witnessing the transition from fossil fuel-based energy to clean energy. Further, this transition is from centralized generation to distributed generation. In this transition, distributed energy resources are likely to play a very important role. Small scale generation from wind and solar power can be utilized for a small area. Low capacity renewable power producers can supply power to end-users through a microgrid. Blockchain can take care of transaction and payments issues using a smart contract.

5.7.1 Applications of Blockchain in Energy Sector

The following prominent applications of blockchain technology in energy can be envisaged:

- Energy trading
- Demand side response
- Decentralized generation
- Grid flexibility
- Electric vehicle charging
- IoT applications
- Green certificates and carbon trading

Now, a few applications of blockchain in energy will be dealt with here.

Energy Trading

One of the significant applications of blockchain technology is in energy trading. Traditionally, in the energy trading sector, the payment process for various services has lagged behind delivery quite significantly. A very long lag between delivery of energy and payment for that delivered energy has been witnessed by imbalance settlement markets where it has taken 28 months for settlement in some cases. Blockchain could speed up the payment for various services using smart contracts. Smart contracts can automatically carry out the payment once the delivery of the energy has been received and verified. Smart contracts can create a more transparent market and reduce other inefficiencies within the existing markets.

As the role of households, both as a consumer and a prosumer, becomes prominent, the volume of transactions will increase, and quick settlement of transactions will be imperative. At present, the trading process involves a multitude of transactions between various participants, which suggests that the trading process is waiting for the possible disintermediating effects of blockchain technology.

Blockchain can help in the growth of peer-to-peer (P2P) energy trading. P2P energy trading will help in increasing the customer's participation in energy trading and involve the customers in the process of energy transition from centralized generation to decentralized generation. In these markets, individuals could offer to sell their excess generation to other market participants. Thus increasing the penetration of small-scale renewable energy sources and bringing flexibility in the energy market.

Demand Response

Demand response is one of the mechanisms of grid balancing. Industries like the Aluminium industry, Appliances like pumps, and consumers, large scale use or small scale use, can be a participant in this demand response. Demand response programs can be encoded in smart contracts and shared among the participants. This could help automate the demand response program as each individual set their preferences.

Green Certificates and Carbon Trading

Another application of blockchain technology is in green certificates and carbon trading. The blockchain is used for the registration and storage of emission credits. Blockchain technology can provide the carbon market with a system that will track the flow of carbon, as well as all transactions and certificates. Carbon trading is carried out through smart contracts.

5.7.2 Projects with Application of Blockchain in Energy Sector

Some of the important projects having the application of blockchain technology in the energy sector have been discussed here.

Brooklyn Microgrid

Brooklyn microgrid designed by LO3 is the most cited project based on blockchain technology in energy. Brooklyn microgrid is a blockchain-based peer to peer energy trading system. In a pilot project, 40 prosumers and 200 consumers will participate in its trading platform. Consumers will be able to bid for excess energy retailed in the market by prosumers using the app.

Grid+

Grid+, based in Texas, aims to give residential consumers better access to participate in wholesale electricity market.

Electron

Electron, a blockchain-based startup based in the UK, is innovating in the energy sector for enabling microgrids and minigrids to trade energy with those requiring energy while ensuring data security, transparency and traceability

EnerPort Project

“EnerPort” is an Irish government- and industry-funded collaborative project where blockchain technology is being used to develop a peer-to-peer (P2P) energy trade model to support energy trade between microgrids.

Check Your Progress 6

In this section, you studied applications of blockchain technology in the energy sector, now answer the questions given in Check Your Progress-6.

Note: a) Write your answer in about 50 words

b) Check your answer with possible answers given at the end of the unit

(1) Enumerate a few applications of blockchain technology in the energy sector.

(2) Discuss a few projects with applications of blockchain in the energy sector.

(3) Discuss the role of blockchain in energy trading.

5.8 SUMMARY

This unit discussed various applications of blockchain technology ranging from the financial industry, education and healthcare industry to insurance, real estate and energy sector. The most popular option has been the smart contract embedded in blockchain at this stage of penetration of blockchain technology in various industries/sectors. Smart contract plays an important role in trade finance in the financial sector. Smart contract plays an important role in the insurance industry. Likewise, the smart contract has extensive use in the real estate sector, where many stakeholders are participating. Similarly, the energy sector is also witnessing the use of the smart contract. The most popular platform for embedding smart contracts in the blockchain is Ethereum. The application of blockchain technology in various industries was discussed and illustrated using a simple and appropriate model.

5.9 KEYWORDS

Badges: Badges represent a way of acknowledging achievements or skill acquisition at a more granular level than a college degree.

Carbon trading: Carbon trade is the buying and selling of credits that permit a company or other entity to emit a certain amount of carbon dioxide. The carbon credits and the carbon trade are authorized by governments with the goal of gradually reducing overall carbon emissions and mitigating their contribution to climate change. Carbon trading is also referred to as carbon emissions trading.

Ethereum: Ethereum is a decentralized, open-source blockchain with smart contract functionality.

Microgrid: Microgrids comprise LV (Low Voltage) distribution systems with distributed energy resources (DER) (solar PV, micro-turbines, etc.) with storage devices (batteries, flywheels) and flexible loads. Microgrids can be operated as autonomous systems or disconnected from the grid or non-

autonomous systems connected to the grid. Microgrid generation capacity is generally 1-10 kW

Minigrid: Systems involving small-scale electricity generation (from 10kW to 10MW) and the distribution of electricity to a limited number of customers via a distribution grid that can operate in isolation from national electricity transmission networks and supply relatively concentrated settlements with electricity at grid quality level.

Prosumers: A prosumer is someone who both produces and consumes energy.

Smart Contract: Smart contracts are translations of an agreement consisting of terms and conditions into computational code (or program/script).

5.10 CHECK YOUR PROGRESS 1 – POSSIBLE ANSWERS

1) Discuss Factoring.

When an exporter ships goods before receiving payment, the accounts receivable balance increases. Since there is a danger that the importer will never pay at all, the exporting firm may consider selling the accounts receivable to a third party. This third party is known as a Factor. The Factor assumes all administrative responsibilities involved in collecting from the importer and the associated credit exposure.

2) What is a Letter of Credit (LC)? Discuss a model of trade finance with LC with blockchain.

A letter of credit (LC) is an instrument issued by a bank on behalf of the importer promising to pay the exporter upon presentation of shipping documents in compliance with the terms stipulated therein. In other words, LC is an undertaking by a bank to make payment on behalf of the importer to the exporter under specified conditions. The exporter is paid upon presentation of the required documents in compliance with the terms of the LC. The LC process involves two banks, the exporter's bank (Correspondent bank) and the importer's bank (Issuing bank).

Blockchain model in trade finance with a LC with blockchain will increase the effectiveness of processes involved. The introduction of a smart contract will make the whole process more effective. The process of execution of a smart contract is like this. The importer writes an application for opening digital LC specifying exporter's details, terms of contract (value of export, i.e. amount, period etc.) and other required characteristics. Then the issuing bank opens a digital LC. The information is added to the block, and the information is visible to participants. When the exporter sends information of delivery of goods to Correspondent bank, the Correspondent bank transfers the amount to the exporter and executes a digital LC. The idea here is to optimize the processes.

(3) What is crowdfunding? How will blockchain bring transparency and security to crowdfunding?

Crowdfunding is internet-enabled ways for startups to raise funds in the form of investments from various individuals. Crowdfunding is an alternative to traditional banking. Recently fundraising through crowdfunding has become very common.

Blockchain technology will help record information related to business registration and keep a record of the nature of business. Funders or investors can access this information very easily. Contracts between fundraisers and

funders using smart contract will bring transparency and protection for funders and keep away fundraisers from unnecessary pressure of funders. In the blockchain based model of crowdfunding, technology is secure and trusted machine. Thereby this model will provide a secure and safe environment for all concerned parties or stakeholders.

Check Your Progress 2 – Possible Answers

1) What are blockchain-based applications in education sector?

There are many blockchain-based applications for educational institutions. The first and the foremost is the certificate/degree verification. Other blockchain-based applications are: fees and credit transfer, learning outcomes management, online learning environment, and evaluation of students' professional ability.

2) What are the benefits of blockchain in the education field?

Following are the benefits of blockchain technology in the education sector:

- Security
- Better Control in Accessing Students' Data
- Accountability and Transparency
- Trust
- Lowering the Cost
- Authentication

3) Discuss the challenges of blockchain technology in education.

There are a lot of potential applications of blockchain technology in the education sector. But there are associated challenges too that need to be addressed. These challenges are in terms of scalability, adoption cost, trust, immutability, to name a few.

Check Your Progress 3 – Possible Answers

1) What is an electronic health record? Discuss a simple electronic health record system model based on blockchain.

Electronic health records (EHR) is a combination of paper-based medical records and electronic medical records. EHR system is efficient and cost-effective as compared to paper-based medical records. The features of EHR are: electronic storage of medical records, patient's appointment management, billings and accounts and lab tests.

A simple EHR system based on blockchain works in the following way:

- Large medical data are collected from patients through mobile applications and EHR system
- Collected data are encrypted and stored in the blockchain network
- The encrypted health advice relayed back to patients individually

2) Discuss the medical fraud detection system.

Drug safety is an important concern as it directly affects public health. So supply chain management in the medical field is an important task. Otherwise, it would be difficult to control counterfeit drug production, fake package recordings and changing labels for polluted drugs in its circulation. Further

supply chain of healthcare involves many moving peoples and parts making it vulnerable for fraudulent attacks. The application of blockchain enables a smart tracking and tracing platform

3) Discuss a few software solutions for applications of blockchain in the healthcare industry.

MeDRec, MeDShare etc. are prototypes of blockchain-based electronic health records. MedRec, developed by Azaria, Ekblaw, Vieira, and Lippman, is a decentralized record management system to handle Electronic Medical Records (EMRs) using blockchain technology. The system allows patients real-time access to their medical information across multiple medical providers and treatment locations. MedRec is built on Ethereum blockchain. MedShare focuses on secure data sharing among different stakeholders in healthcare. MeDShare uses blockchain technology with cloud services for keeping medical data safe and secure. MeDShare uses a smart contract and access control mechanism to track the data and revoke access to any malicious entity.

Check Your Progress 4 – Possible Answers

1) Why blockchain technology is required in the insurance sector?

The settlement of claims is not very smooth as far as the insurance industry is concerned. The traditional contract method is not foolproof. There is a lack of transparency, and there are certain loopholes. Both the policyholders and insurance companies feel exploited. Smart contracts on blockchain can substantially address these problems by bringing transparency and trust.

2) Discuss a simple insurance model with blockchain.

In a simple insurance model, there are two entities. One is 'Client' and the other 'Agent'. The 'Client' is one who is covered by insurance. The client may request the following processes:

- Registration
- Policy assignment
- Paying premium
- Submitting claim
- Processing refund

The 'Agent' acts on behalf of the 'Client' and processes 'Client's' request on blockchain network.

The execution of each transaction and result is maintained by blockchain. The rules of transactions are governed by a smart contract. Each smart contract consists of verification logic specifying conditions under which transaction has to be executed by a smart contract. The smart contract is for all processes or transactions beginning with the registration to issue of policy, premium payment, claim and refund.

3) Discuss examples based on a smart contract on blockchain technology in the insurance sector.

Some of the examples based on a smart contract on blockchain technology are listed below:

Flight Insurance

Several start-ups as well as established insurance companies have launched flight insurance policies built on a blockchain with smart contracts. A travel insurance product called Fizzy was brought by AXA, a French insurer. Fizzy is based on blockchain technology. The insurance product for flight travellers is about delay in flight by more than two hours. The travellers are compensated automatically without manual intervention when a flight is delayed by more than two hours. The policy details are coded in a smart contract. The process of compensation is transparent and much faster as the decision lies with the smart contract.

Marine Insurance

Maersk has partnered with E&Y and Microsoft to build a blockchain-based insurance solution for its fleet of ships. The goal is to make the auditing process of the supply chain easier.

Check Your Progress 5 – Possible Answers

- 1) Discuss the transaction process using a blockchain-based system for buying a property in the real estate sector.

Following are the transaction processes involved in blockchain technology-based system for buying property:

- A buyer searches the property through Multi Listing Services (MLS). Multi Listing Services is a centralized database of real estate properties for brokers and agents to facilitate buyers to choose property. But there is a problem with the existing MLS. The information provided through MLS may be inaccurate, outdated or incomplete. This problem can be overcome by the use of blockchain. The introduction of blockchain will help in data getting distributed across a peer-to-peer network. The registered users will publish data related to a property using a smart contract on blockchain-enabled MLS. The registration will ensure the unique identity of the owner and his/her associated property. Decision to include or exclude the new listing will be based on common consensus mechanism involving all peers. Thus blockchain-based MLS will be more reliable as compared to traditional MLS.
- After searching a property, a buyer can visit the site physically or using virtual reality (VR).
- A formal agreement is signed between the buyer and the seller. After that, both parties will do due diligence and background verification.
- Manual verification is fraught with many mistrust and inefficiencies. The smart contract will make the whole process transparent and reliable. A smart contract can be developed in Ethereum using its programming code known as solidity.
- The key terms of the agreement are recorded and embedded to the blockchain.
- Then automatic payment is initiated.
- Finally, the seller transfers the property possession to the buyer after getting payment.

- 2) List a few information contained in the smart contract of real estate.

A general Smart contract for buying a property in the real estate sector should include the following information:

- Owner's address
- Buyer's address
- Purchase Id of the property
- Purchase value of the property
- Buying agreement template
- Purchase payment

Check Your Progress 6 – Possible Answers

1) Enumerate a few applications of blockchain technology in the energy sector.

The following are prominent applications of blockchain technology in the energy sector:

- Energy trading
- Demand side response
- Decentralized generation
- Grid flexibility
- Electric vehicle charging
- IoT applications
- Green certificates and carbon trading

2) Discuss a few projects with applications of blockchain in the energy sector.

Some of the important projects having the application of blockchain technology in the energy sector are as below:

Brooklyn Microgrid

Brooklyn microgrid designed by LO3 is the most cited project based on blockchain technology in energy. Brooklyn microgrid is a blockchain-based peer to peer energy trading system. In a pilot project, 40 prosumers and 200 consumers will participate in its trading platform. Consumers will be able to bid for excess energy retailed in the market by prosumers using the app.

Grid+

Grid+, based in Texas, aims to give residential consumers better access to participate in wholesale electricity market.

Electron

Electron, a blockchain-based startup based in the UK, is innovating in the energy sector for enabling microgrids and minigrids to trade energy with those requiring energy while ensuring data security, transparency and traceability

3) Discuss the role of blockchain in energy trading

One of the significant applications of blockchain technology is in energy trading. Traditionally in the energy trading sector the payment process for various services has lagged behind delivery quite significantly. A very long lag between delivery of energy and payment for that delivered energy has been witnessed by imbalance settlement markets where it has taken 28 months for settlement in some cases. Blockchain could speed up the payment for various services using smart contracts. Smart contracts can automatically carry out the payment once the delivery of the energy has been received and verified. Smart contracts can create a more transparent market and reduce other inefficiencies within the existing markets.

Blockchain can help in the growth of peer-to-peer (P2P) energy trading. P2P energy trading will help in increasing the customer's participation in energy trading and involve the customers in the process of energy transition from centralized generation to decentralized generation. In these markets, individuals could offer to sell their excess generation to other market participants. Thus increasing the penetration of small-scale renewable energy sources and bringing flexibility in the energy market.

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