# DECENTRALIZED MEDICINE SUPPLY CHAIN MANAGEMENT AND ELIMINATE COUNTERFEIT MEDICINE USING BLOCKCHAIN

**Dr.N.Pughazendi**
Professor
Department Of Computer Science and Engineering
Panimalar Engineering College
pughazendi@gmail.com

**Thyagarajan C**
Assistant Professor
Department Of Computer Science and Engineering
Panimalar Engineering College
thyaguwinner@gmail.com

**Sundaresan R, Sathish kumar T P, Vishal S**
Department Of Computer Science and Engineering
Panimalar Engineering College
sundaresan.dr007@gmail.com          sksathish3001@gmail.com          vishalselvakumar23@gmail.com

## Abstract

*Blockchain is evolving to be a secure and reliable platform for secure data sharing in application areas such as the financial sector, supply chain management, food industry, energy sector, internet of things and healthcare. In this paper, we review existing literature and applications available for the supply chain system using blockchain technology. Besides, this work also proposes multiple workflows involved in the medicine supply chain management using blockchain technology for better data management. Medicine supply chains are complex structures spanning across multiple organizational and geographical boundaries, providing critical backbone to services vital for everyday life. The inherent complexity of such systems can introduce impurities including inaccurate information, lack of transparency, and limited data provenance. Counterfeit drugs is one consequence of such limitations within existing supply chains which not only has serious adverse impact on human health but also causes severe economic loss to the pharamacitical industry .Different medical workflows have been designed and implemented using the ethereum blockchain platform which involves complex medical procedures like storing and retrieving data The illicit drug market contributes significantly to the production of counterfeit drugs as its additives and add contaminated, improperly stored, and counterfeit ingredients. This also includes accessing and managing a large amount of medical data. The global counterfeit drug trade impacts all pharmaceutical stakeholders including hospitals, pharmacies, wholesale distributors, global health programs, and regulatory authorities. Within the implementation of the workflows of the medical smart contract system for supply chain management, the associated cost has been estimated for this system in terms of a feasibility study which has been comprehensively presented in this paper. This work would facilitate multiple stakeholders who are involved within the medical system to deliver better medicines/drugs and optimize cost.*

*Keywords: Ethereum, DApp, Blockchain, Medicine Supplychain Management, Eliminate Counterfeit Medicine.*

## I.INTRODUCTION

The main issues with drug safety in the counterfeit medicine supply chain, are to do with how the drugs are initially manufactured. The traceability of right and active pharmaceutical ingredients during actual manufacture is a difficult process, so detecting drugs that do not contain the intended active ingredients can ultimately lead to end consumer patient harm or even death. Blockchain's advanced features make it capable of providing a basis for complete traceability of drugs, from manufacturer to end consumer, and the ability to identify counterfeit-drug. The smart contract guarantees data provenance eliminates the need for intermediaries and provides a secure, immutable history of transactions to all stakeholders. The counterfeiting of medicines causes the serious threat to the society. The counterfeited medicines make an adverse effect on the health of the people and also cause revenue loss to the legitimate medicine manufacturing organizations. Using conventional databases, this type of record keeping was not secure, and patient's privacy was at risk, but using blockchain, patient's data can be stored without sharing his private record. To tackle these challenges, we've implemented a decentralized database and a smart contract in our dApp, which stops counterfeit medicine supply. One of the greatest advantages and selling points of blockchain technology is its resilience against various types of attacks, including cyberattacks. The role of drug regulatory authorities includes quality checks and monitor the quality, safety, and efficacy and post market surveillance of pharmaceutical products.

Blockchain solutions for supply chain and logistics have recently gained enormous acceptance as they provide an immutable and transparent way to record transactions between non-trusting stakeholders. The importance of drug traceability (track and trace) is increasingly emphasized and mandated by several countries across the world. A pharmaceutical supply chain follows an end-to-end process from sourcing the active medication ingredients (source) to manufacturing the final product (medication) distributed and delivered to patients (end-users). Visibility and privacy are mostly opposite to each other and to obtain one we often lose the other. Blockchain is the best technology for the trade-off that can guaranty to verify the originality of a piece of data that is made available publically while keeping the private data of an entity secrete and without any compromise on privacy. It opens up possibilities of designing and developing a secure, transparent and decentralized system with the absence of a third party for access and control. Blockchain technology enables creating a private permissioned network to trace and track events in the pharmaceutical supply chain. One of the greatest advantages and selling points of blockchain technology is its resilience against various types of attacks, including cyberattacks. The role of drug regulatory authorities includes quality checks and monitor the quality, safety, and efficacy and post market surveillance of pharmaceutical products. This process minimizes the impediments in the drug supply chain, empowers collaboration between mutually untrusted stakeholders and creates an unassailable and immutable decentralized drug traceability system.

## II.PROBLEM STATEMENT

The primary reason for counterfeit drugs to reach end-user marketplace is due to the complex structure of a medicine supply chain. Leveraging the complexity of this distribution process, medications can easily pass through with little or no trail of

information and verifiable documentation.

A lack of visibility into the supply chain may be the root of many challenges faced by the pharmaceutical industry. Drug shortages. Counterfeits. Medicine supply chain issues come down to differences in processes or systems. A single drug or treatment may be administered to hundreds of hospitals through distributors. it can be tough to keep track of and meet each buyer's requirements. Poor compliance can cost millions in penalties, incarceration for supply chain leaders, and increase the risk of harm to consumer. A cold chain is a temperature-controlled supply chain. It typically involves constant refrigeration of the product from the time of its production through its transportation, handling, storage, and delivery.

## III. LITERATURE SURVEY

**U. Padmavathi and N. Rajagopalan[1],2021** Medical equipment must go through rigorous certification processes that differ based on the healthcare rules and certifications in each country. This complicates the supply and delivery of medical devices and supplies, which are urgently needed. Through blockchain-based decentralised digital manufacturing, the extensive and lengthy testing procedures, as well as the large distances that threaten traceability, fast response, security, and trust, can be achieved. In 2008, the concept of blockchain technology was introduced. Decentralization, audit, immutability, traceability, security, and trust are all unique aspects of blockchain. It is administered by clusters, which are groups of computer nodes that collaborate to validate and execute transactions. Cryptography (hashes) and digital signatures are used in the technology, with two keys— public and private—generated from the Ethereum address.

**Ekblaw, A.; Azaria, A.; Halamka, J.D.; Lippman, A [2], 2016** One of the most revolutionary technologies of the future is blockchain. It records and transmits transparent, secure, controlled, and fault-tolerant data using distributed ledger technology. Blockchain can help organisations become decentralised, transparent, efficient, democratic, and safe. Many blockchain platforms have been proposed in the literature over the years. Public Blockchain, Private Blockchain, and Consortium Blockchain are three types of blockchain applications that can be classified. The MedRec is a bitcoin-based solution aimed at addressing challenges such as system interoperability, sluggish access to medical data, patient, agency, and fragmentation, among others. Patients have comprehensive access to medical information and immutable logs across providers thanks to the revolutionary blockchain-based system.

**Francisco K and Swanson D [3],2018** All pharmaceutical stakeholders, including hospitals, pharmacies, wholesale distributors, global health initiatives, and regulatory bodies, are affected by the global counterfeit medicine trade. As its actors add tainted, inadequately maintained, and falsified substances, the illegal drug market contributes significantly to the production of phoney and fraudulent medicines. Blockchain technology allows for the creation of a private permissioned network that may be used to trace and track events in the pharmaceutical supply chain while also providing time stamped records of each transaction. Execution and owner, time, transaction location, and which parties were involved are all examples of occurrences.

**Lemieux, V.L [4] ,2016** Legacy systems in the medical and healthcare fields often only share healthcare resources internally and are not entirely compatible with external systems. Despite this, evidence suggests that combining these networks for integrated and improved healthcare has various advantages, necessitating connectivity between different companies for health informatics researchers. Multi-organizational data exchange is a key issue that requires medical data gathered by a healthcare provider to be freely accessible to other organisations, such as a physician or research institute. Blockchain technology is redefining data processing and governance in many healthcare systems. This is due to its adaptability and unrivalled segmentation, security, and data and service sharing. Blockchain technology is at the forefront of many contemporary advances in the healthcare business.

**Kumar, T.; Ramani, V.; Ahmad, I.; Braeken, A; Harjula, E; Ylianttila [5],2018** Smart contracts and blockchain how smart contracts based on the blockchain have the ability to handle several healthcare issues They took some early measures to utilize blockchain technology for various healthcare use cases and identified various hurdles in blockchain implementation in their work. They went on to say that developing blockchain-based apps can more effectively address healthcare challenges, with security and privacy aspects of data and personal information management underpinning all blockchain implementations. It is the worth of data processing that is secure in the sense that it cannot be distorted. In this digital age, access to personal data has become a concern, with security and privacy issues to contend with. Due to hacking motivations and privacy violations, digital security is a serious concern. This is achievable in the eHealth field, where a patient's health information management system must adhere to several regulations while staying accessible to officially authorized healthcare practitioners.

**Medicalchain Whitepaper 2.1. Tech. Rep. Medicalchain[6], 2018** MedicalChain solves these issues by creating a smart healthcare ecosystem by storing medical record transactions on the blockchain. A smart contract is launched in MedicalChain to provide time-limited access to a patient's electronic health record. Doctors keep track of their notes and scan lab findings, which are then logged as transactions. The pharmacy fills prescriptions and logs the transaction on the blockchain. The patient grants their insurer time-limited access to verify treatment and settle payments. The patient grants their insurer time-limited access to verify treatment and settle payments. Patients can use smart contracts to allow doctors to assess medical issues remotely and provide advice or a second opinion.

**Schlegel, M.; Zavolokina, L.; Schwabe, G. [7],2018** . Tokens can be used to raise funds for new initiatives and can be exchanged for products, services, or cash. Several blockchain-based firms have raised millions of dollars through token sales, including Starbase. Buying and selling real estate is tough nowadays due to a lack of openness and inaccuracies in public records. Blockchain technology is also employed in the real estate market to keep records secure, transparent, and to speed up the buying and selling process. The decentralised distributed ledger provides document correctness, tracking, ownership verification, and property deed transfers. Ubitquity is a secure platform for real-estate records-keeping that uses blockchain technology instead of a legacy system.

**Zhang, A; Lin, X.; [8] 2018,** To assure correct identification, tracing, tracking, and provenance, blockchain technology provides an efficient and cost-effective solution that underpins various medication traceability tasks and procedures. Data is now more secure than it has ever been because to the advent of blockchain technology. Despite the fact that the blockchain ledger is shared, the data is encrypted and authenticated using advanced cryptography methods. This cryptography algorithm keeps data safe from theft while simultaneously maintaining its integrity. Medical researchers, health care professionals, and individuals can all benefit from blockchain technology. The creation of a single storage site for all health data, real-time tracking of personalised data, and granular data access permissions will benefit both research and personalised care.

# BLOCKCHAIN MINING

Blockchain mining involves adding transactions to the existing blockchain ledger of transactions distributed among all users of a blockchain. While mining is mostly associated with bitcoin, other technologies using a blockchain employ mining as well. Mining involves creating a hash of a block of transactions that cannot be easily forged, protecting the integrity of the entire blockchain without the need for a central system.

Mining is typically done on a dedicated computer, as it requires a fast CPU, as well as higher electricity usage and more heat generated than typical computer operations. The main incentive for mining is that users who choose to use a computer for mining are rewarded for doing so. In the case of bitcoin, it is 25 bitcoins per hash. That is why some hackers use machines they break into to mine bitcoins, getting an unwitting victim to pay for the costs of mining while reaping none of the benefits.

| Coin | Hardware class | Algorithm | New coins / day | Hash Rate | Hash units | Price 5/30/2019 US$ | Economic Production per Day, Million $ | Extrapolated Annual Production Million $ |
|------|------|------|------|------|------|------|------|------|
| Bitcoin | ASIC | SHA256 | 1800 | 47.1 | Exa | 8701 | 15.662 | 5,717 |
| Ethereum | ASIC | Ethash | 13,600 | 172 | Tera | 284 | 3.862 | 1,410 |
| Litecoin | ASIC | Scrypt | 14,825 | 352 | Tera | 117.6 | 1.743 | 636 |
| Bitcoin Cash | ASIC | SHA256 | 1800 | 1.36 | Exa | 469 | 0.844 | 308 |
| Zcash | ASIC | Equihash | 7200 | 4 | Giga | 86.9 | 0.626 | 228 |
| Bitcoin SV | ASIC | SHA256 | 1800 | 2.03 | Peta | 222 | 0.400 | 146 |
| Dash | ASIC | X11 | 1693 | 1.68 | Peta | 172.2 | 0.292 | 107 |
| Monero | GPU | CryptoNight | 1934 | 329 | Mega | 95.1 | 0.184 | 67 |
| Totals | | | | | | | 23.61 | 8,619 |

Fig.1 Top 8 Mined coins

From above Fig.1, table demonstrate which is across all pools, not just the Top 50, we see that total annual economic value run rate (extrapolated from the recent average daily values) is about $8.6 billion. About 2/3 of the economic value created is from Bitcoin production alone, with about $15 million produced per day recently. Ethereum amounts to around one-quarter of that at almost $4 million per day. The next six coins add another $4 million daily. Overall, around $24 million per day is currently being mined from all pools.

The locations of top mining pools can be multi-country. The next Table summarizes the major host countries for the Top 50 pools; China, the US, and Hong Kong account for 70% of the top 50 pools and almost all of the top 10 operators. China alone is responsible for nearly half of the annual value produced by the Top 50 pools. The Mixed category includes various combinations of US, China, the EU, Russia, or other Asian or European countries. This category has grown as Chinese operators begin to move to other geographies, as a result of pressure from the government to constrain cryptocurrency mining in China.

## IV. OUR METHODOLOGY

The purpose of the new system is to incorporate the features of blockchain technology and add traceability, and security to the drugs supply chain, and to provide visibility to manufacturers and drugs regulatory authority of the SUPPLY CHAIN MANAGEMENT system.

### 1. To Increase Trust and Transparency:

The manufacturer and customers being able to track pharmaceutical products throughout the supply chain, they will trust each other.

### 2. Traceability:

Once the manufacturer produces a product, he will register it on the blockchain, and here after the drugs will be tracked, traced and authenticated at each stage of their journey. As the drugs ownership change physically, its ownership will be transferred simultaneously on the blockchain network. Drugs manufacturers will be able to see the journey of their products at any of time, from manufacturing to packagers, and from packagers to distributers.

### 3. Add Visibility and Protect Privacy:

Visibility and privacy are mostly opposite to each other and to obtain one we often lose the other. Blockchain is the best technology for the trade-off that can guaranty to verify the originality of a piece of data that is made available publically while keeping the private data of an entity secrete and without any compromise on privacy.

### 4. Extended Security:

Blockchain is considered as one of the most secured ledger systems on the planet. Blockchain is an immutable database and the information once stored on it, it cannot be deleted or modified.

### 5. Database for Future Statistics:

Using conventional databases, this type of record keeping was not secure, and patient's privacy was at risk, but using blockchain, patient's data can be stored without sharing his private record.

## V. WORKING PRINCIPLE: PROJECT EXPLANATION

The Working of Medicine Supply chain Management System(fig.2). At first Step, Storing the necessary details of the user. The Manufacturer, The Supplier, The Consumer give their information and complete the registration process in the Medbloc Application. The information is gathered and stored in the cloud storage. Once the manufacturer produces a product, he will register it on the blockchain, and here after the drugs will be tracked, traced and authenticated at each stage of their journey As the drugs ownership change physically, its ownership will be transferred simultaneously on the blockchain network. Drugs manufacturers will be able to see the journey of their products at any of time, from manufacturing to packagers, and from packagers to distributers.
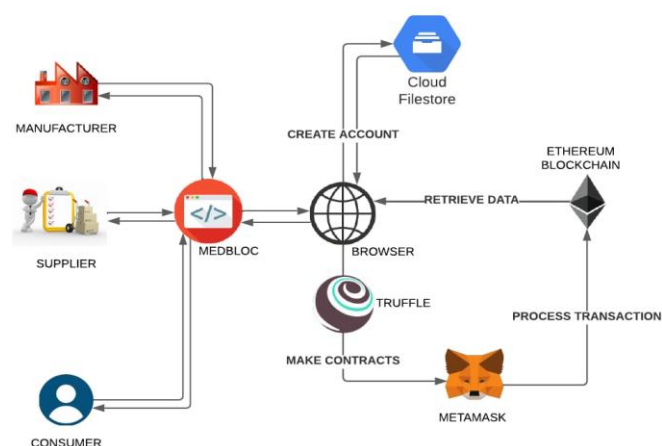


**FIG.2.Working Flow**

The user fills the login credentials the application, then the application verifies the user account details and stores in the Firebase and the User account is created, then the user can login in the application using email ID and Password. The Manufacturer

login into the MEDBLOC by verifying the credentials and store the medicine details,this transaction is recorded in the Ethereum Blockchain. The manufacturer generates QR code for the medicine details stored in the blockchain. The supplier accesses the blockchain and authenticate the originality of the stock, then the transaction is processed in the blockchain network. QR code are created for the products which can be downloaded by the users.The Medbloc retrieve the Medicine data from the Blockchain and stores the verification details in the Blockchain. The Supplier distribute the medicine to the Consumer after completion of the authentication process. The consumer can purchase the medicine and verify its authenticity by scanning or upload the QR code and check the details in the blockchain network. MEDBLOC incorporates the features of blockchain technology and add traceability, and security to the drugs supply chain, and to provide visibility to manufacturers and drugs regulatory authority of the SUPPLY CHAIN MANAGEMENT system.

## VI.PROJECT MODULES

**User Details Registration:**

This module represents the User details registration process. In this module there is a sequence of steps. First step indicates, Storing the necessary details of the user. The Manufacturer, The Supplier, The Consumer give their information and complete the registration process in the Medbloc Application. The information is gathered and stored in the cloud storage.

**User Account Creation:**

This module explains how the user creates an account in the MEDBLOC Application. The user fills the login credentials the application, then the application verifies the user account details and stores in the Firebase and the User account is created, then the user can login in the application using email ID and Password.

**Add Medicine details:**

In this module we are going to add medicine details of the products created by the registered Manufacturer .The Manufacturer Login into the MEDBLOC by verifying the credentials and store the medicine details,this transaction is recorded in the Ethereum Blockchain. The manufacturer generates QR code for the medicine details stored in the blockchain.Then the manufacturer uploads the QR code to the Supplier which is further used to access the Medicine details.
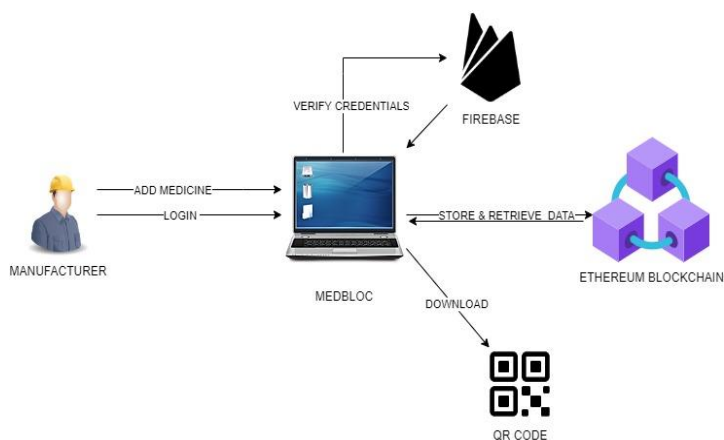


**FIG.3 Add Medicine details**

**Verify Medicine details:**

In this Module, The Supplier logins in the application by verifying the login credentials and scans the QR code uploaded by the Manufacturer and retrieve data from the Medbloc application. The Medbloc retrieve the Medicine data from the Blockchain and stores the verification details in the Blockchain. The Supplier distribute the medicine to the

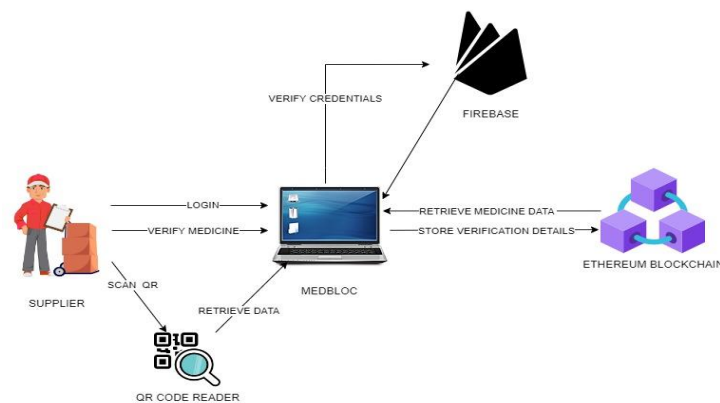Consumer after completion of the authentication process.



**FIG.4. Verify Medicine details**

**Check Medicine details:**

In this module, the Consumer login in the Medbloc application using the login credentials, the application verifies the consumer details in stored in Firebase. The Consumer upload the QR code of the medicine purchased from the Supplier in the application. Medbloc retrieve medicine details from the Blockchain and displays the result in the application, then the Consumer check the result whether the medicine purchased is original or counterfeit.
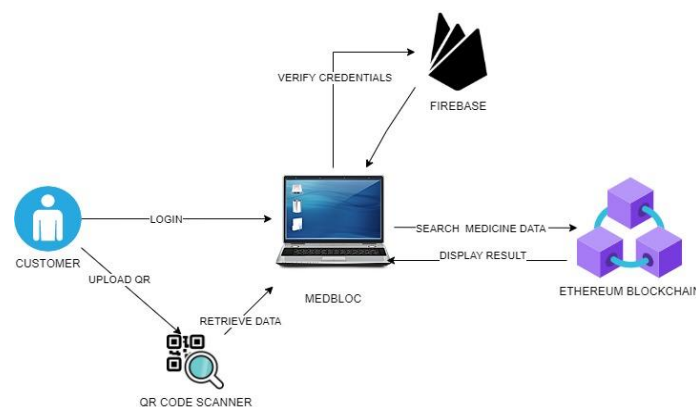


**FIG.5. Check Medicine details**

## VII.RESULTS & DISCUSSION

The purpose of MEDBLOC to incorporate the features of blockchain technology and add traceability, and security to the drugs supply chain, and to provide visibility to manufacturers and drugs regulatory authority of the SUPPLY CHAIN MANAGEMENT system. The distributed ledger technology records the immutable and transparent transactions, logs, and histories of all events and actions taken in the network. The manufacturer and customers being able to track pharmaceutical products throughout the supply chain, they will trust each other. Once the manufacturer produces a product, he will register it on the blockchain, and here after the drugs will be tracked, traced and authenticated at each stage of their journey. As the drugs ownership change physically, its ownership will be transferred simultaneously on the blockchain network. Drugs manufacturers will be able to see the journey of their products at any of time, from manufacturing to packagers, and from packagers to distributers. Blockchain is the best technology for the trade-off that can guaranty to verify the originality of a piece of data that is made available public while keeping the private data of an entity secrete and without any compromise on privacy. The supplier accesses the blockchain and authenticate the originality of the stock, then the transaction is processed in the blockchain network. QR code are created for the products which can be downloaded by the users. The consumer can purchase the medicine and verify its authenticity by scanning or upload the QR code and check the details in the blockchain network.
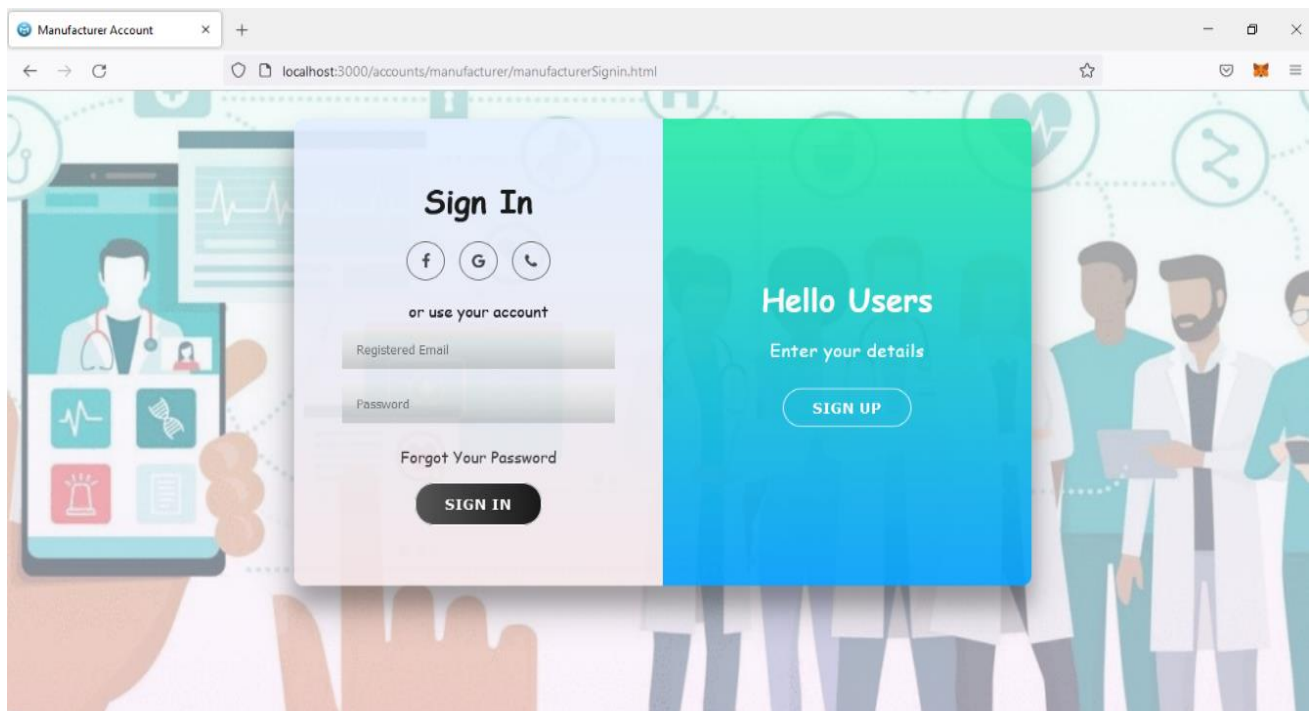
*FIG.6* **Screenshot of account login page**

In this page (Fig.6), Manufacturer login into the Medbloc application and record the medicine details. The Supplier receives the medicine and login in Medbloc application and authenticate it using the QR Code. The Consumer login Medbloc application and verify its authenticity. All these activities are performed by accessing into the Medbloc login page.



**FIG.7 Screenshot of manufacturer entered medicine details in blockchain**

In this page (Fig.7), Manufacturer records the medicine details and generates the QR Code for the medicine and uploaded it. The Supplier will authenticate the QR code uploaded by the Manufacturer and authenticate the details of the medicine in the Blockchain. The Consumer purchase the Medicine from the Supplier and Scan the QR code to Check the details of Medicine from the Ethereum Blockchain. All these transactions are recorded and processed automatically into the Blockchain in the MEDBLOC application.
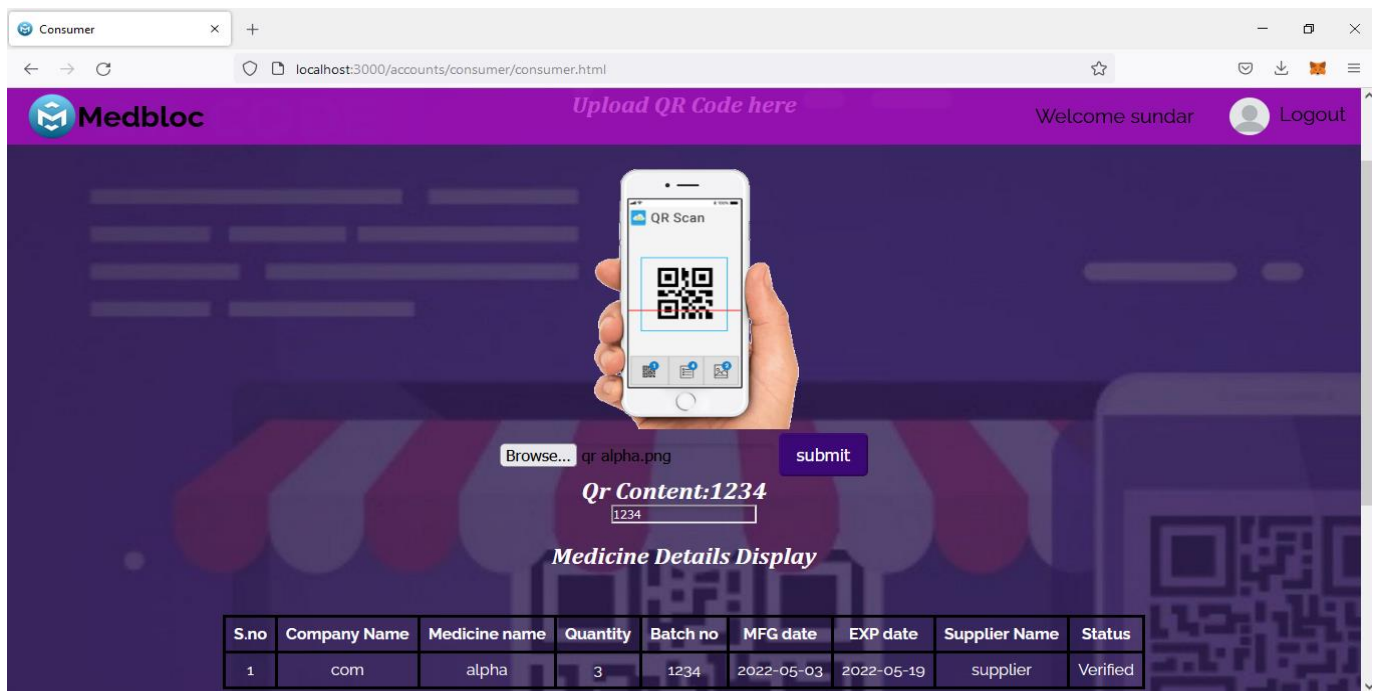
**FIG.8 *Screenshot* of consumer page to check a medicine**

In this page (Fig.8), Consumer upload the QR code of the medicine purchased from the Supplier in the application. Medbloc retrieve medicine details from the Blockchain and displays the result in the application, then the Consumer check the result whether the medicine purchased is original or counterfeit.
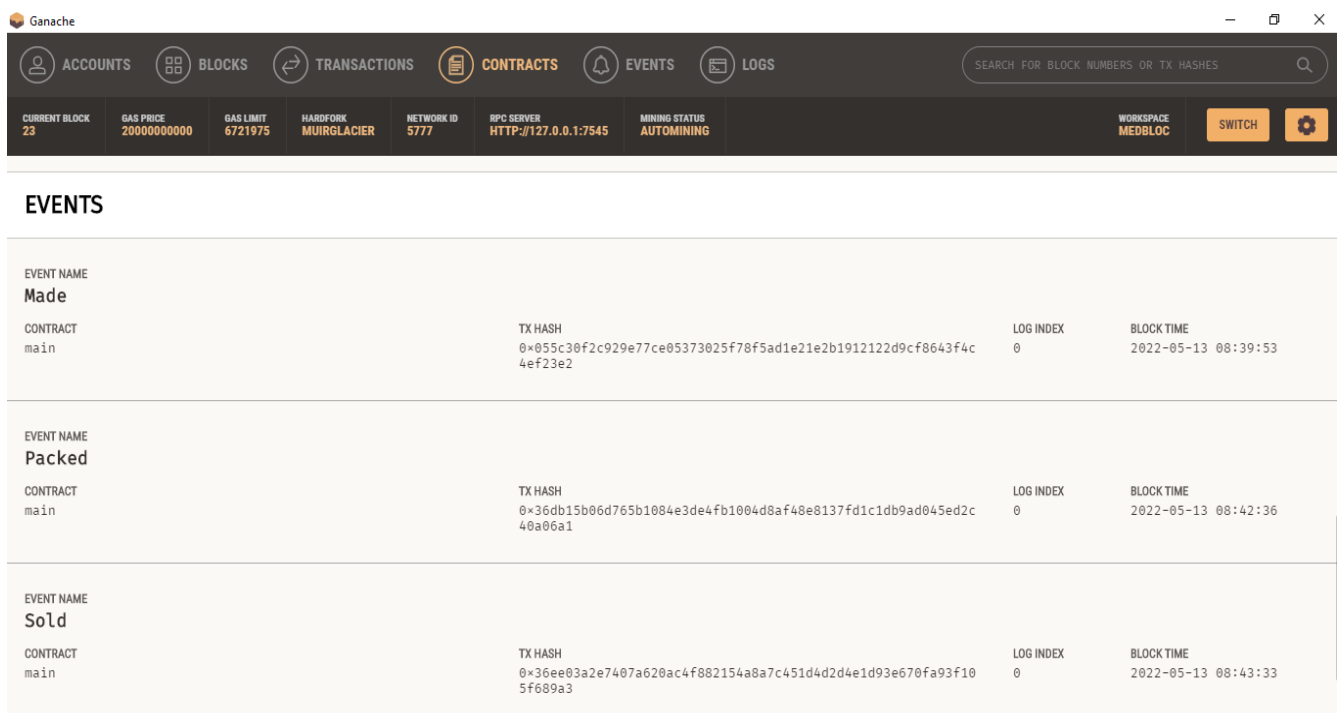


**FIG.9 Screenshot of medicine details entered in blockchain**

In this page (Fig.9), The Manufacturer, The Supplier, The Consumer performed their tasks in the Medbloc Application. The information is gathered and stored in the cloud in the block chain. Once the manufacturer produces a product, he will register it on the blockchain, and here after the drugs will be tracked, traced and authenticated at each stage of their journey.

## IX.CONCLUSION:

Thus, this project has many advantages and provides a scope of improvement in the future product supply chain field. One of the greatest advantages and selling points of blockchain technology is its resilience against various types of attacks, including cyberattacks. The role of drug regulatory authorities includes quality checks and monitor the quality, safety, and efficacy and post market surveillance of pharmaceutical products. The manufacturer and customers being able to track pharmaceutical products throughout the supply chain, they will trust each other is the main objective of the project. There is also a scope extending of the present idea in Healthcare, E-commerce and other activities that needs Automated Decentralized Application management system.

## X.FUTURE ENHANCEMENT:

The Medbloc application is a single platform web application. we can create Android application for Medbloc and integrated different platform users together and improve accessibility. We can implement Medbloc for other blockchain applications. We can implement decentralized application into larger and diverse platforms. We can change to a different blockchain which offers cheaper gas price. Decentralized application can be implemented in healthcare, Banking, Ecommerce and other area which required more transparency and high security.

## XI. REFERENCES

1. Zyskind, G.; Nathan, O. Decentralizing privacy: Using blockchain to protect personal data. In Proceedings
of the 2015 IEEE Security and Privacy Workshops, San Jose, CA, USA, 21–22 May 2015.

2. Bryatov, S.R.; Borodinov, A.A. Blockchain Technology in the Pharmaceutical Supply Chain: Researching a Business
Model Based on Hyperledger Fabric; International Conference on Information Technology and Nanotechnology
(ITNT): Samara, Russia, 2019.

3. Engelhardt, M.A. Hitching healthcare to the chain: An introduction to blockchain technology in the healthcare
sector. Technol. Innov. Manag. Rev. 2017,

4. Decker, C.; Wattenhofer, R. Information propagation in the bitcoin network. In Proceedings of the IEEE P2P
2013 Proceedings, Trento, Italy, September 2013.

5. Dennis, R.; Owen, G. Rep on the block: A next generation reputation system based on the blockchain.
In Proceedings of the 2015 10th International Conference for Internet Technology and Secured Transactions
(ICITST), London, UK, 14–16 December 2015.

6. Puthal, D.; Malik, N.; Mohanty, S.P.; Kougianos, E.; Das, G. Everything you wanted to know about the
blockchain: Its promise, components, processes, and problems. IEEE Consum. Electron. Mag. 2018, 7,

7. Liang, X.; Zhao, J.; Shetty, S.; Liu, J.; Li, D. Integrating blockchain for data sharing and collaboration in mobile
healthcare applications. In Proceedings of the 2017 IEEE 28th Annual International Symposium on Personal,
Indoor, and Mobile Radio Communications (PIMRC), Montreal, QC, Canada, 8–13 October 2017.

8. Zhang, P.; Walker, M.A.; White, J.; Schmidt, D.C.; Lenz, G.Metrics for assessing blockchain-based healthcare decentralized apps. In Proceedings of the 2017 IEEE 19th International Conference on e-Health Networking,
Applications and Services (Healthcom), Dalian, China, 12–15 October 2017.

9. Yue, X.; Wang, H.; Jin, D.; Li, M.; Jiang, W. Healthcare data gateways: Found healthcare intelligence on
blockchain with novel privacy risk control. J. Med. Syst. 2016, 40

10. Witchey, N.J. Healthcare Transaction Validation via Blockchain, Systems and Methods. U.S. Patent
No. 10,340,038, 2 July 2019.

11. Rabah, K.V.O. Challenges & opportunities for blockchain powered healthcare systems: A review. Mara Res.
J. Med. Health Sci. 2017,

12. Hölbl, M.; Kompara, M.; Kamisalic, A.; Zlatolas, L.N. A systematic review of the use of blockchain in
healthcare. Symmetry 2018,

13. McGhin, T.; Choo, K.-K.R.; Liu, C.Z.; He, D. Blockchain in healthcare applications: Research challenges and
opportunities. J. Netw. Comput. Appl. 2019,

14. Esposito, C.; De Santis, A.; Tortora, G.; Chang, H.; Choo, K.K.R. Blockchain: A panacea for healthcare
cloud-based data security and privacy? IEEE Cloud Comput. 2018,

15. Bocek, T.; Rodrigues, B.B.; Strasser, T.; Stiller, B. Blockchains everywhere—A use-case of blockchains in the
pharma supply-chain. In Proceedings of the 2017 IFIP/IEEE Symposium on Integrated Network and Service
Management (IM), Lisbon, Portugal, 8–12 May 2017.

16.Linn, L.A.; Martha, B.K. Blockchain for Health Data and Its Potential Use in Health It and Health Care
Related Research. In Use of Blockchain for Healthcare and Research Workshop; ONC/NIST: Gaithersburg, MD,
USA, 2016