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Smart Contract-Based Procurement in Supply Chain Sector

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Abstract:
Efficiently managing and tracking shipments is important for service providers in global trade. In spite of major advances in new technologies service providers still suffer from information opaqueness, poor procurement, real-time tracking and process complexity, and so on. In this paper, we proposed automating procurement contracts in the supply chain integrating blockchain technology and decentralized storage using the Ethereum network enabling transparency, streamlining communication among trading partners, and minimizing the procurement timeline while avoiding pricing discrepancies and inaccuracies. We have used Role-based access control methodology and keccack256 for comparing keys at delivery partners. We attempt a generic framework with detailed algorithms depicting various interactions among trading partners.

Index Terms*— Blockchain, Ethereum, security analysis, blockchain applications, group purchasing organizations, service providers, Interplanetary File System (IPFS)*

I. INTRODUCTION

The current contract in client spending because of international fluctuations in distribution charges has accelerated the significance of enhancing the product distribution shape. The want for brand new techniques to offer records to clients has accelerated, and, as a result, a distribution charge disclosure device has been added in lots of countries. However, distribution charges are unstable, and the distribution shape is regularly now no longer transparently operated because of the closed and various supply chain management (SCM) operations of companies. The SCM framework become first added in 2000 as a brand new enterprise version and a manner to strategically manipulate relationships with key clients and suppliers. In fact, many businesses are the use this machine to control their distribution shape and make profits. However, this kind of machine with many stakeholders has a complex distribution shape and an excessive distribution margin. In addition, there may be no manner for purchasers to attain facts transparently approximately the margins of the product consistent with the distribution channel.

To solve these problems and increase this framework, we intend to introduce blockchain technology, that can beautify the safety of facts control and display the operating system transparently. Data control structures primarily based totally on blockchain were actively researched. A comparable gadget has been used for the primary time in finance, however, this method has been slowly spreading to numerous fields, along with manufacturing, distribution, scientific care, cloud computing, and public services. A new paradigm of control decentralization has revolutionized the enterprise as a whole. We agree that the structures that observe will increase SCM similarly and provide clients self-belief in its usage.

The supply chain suffers from tremendously fragmented structures, out-of-date methods and systems, and disconnectedness in record sharing amongst stakeholders. The problem does now no longer restrict itself to fragmented records however extends to a loss of acceptance as true with and transparency amongst buying and selling partners. Furthermore, immoderate transaction costs, rate discrepancies, negative forecasting methods, and distribution practices act as obstacles in the direction of improving the delivery chain.

Even though GPOs offer numerous blessings to their providers, they face numerous demanding situations especially associated with goods shortages and settlement management techniques. The present technique of settlement negotiation among a goods producer and GPO includes numerous steps, inclusive of disputes, rebate payments, chargebacks, and adjudication. Moreover, the technique is time-ingesting and normally takes greater than a month to finalize the settlement a good way to be administered to service providers. Another crucial assignment withinside the present-day technique includes making sure that all stakeholders are concurrently knowledgeable concerning the contracts and pricing updates. Hence, in this paper, we endorse integrating blockchain generation to automate the GPO settlement technique to hurry up the management technique and useful resources in improving the supply chain operation.

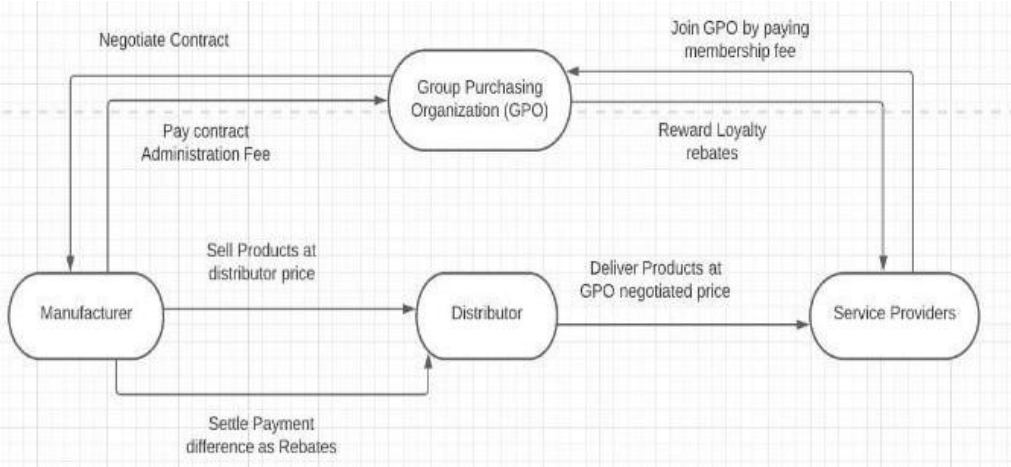

Figure 1. GPO contracting procedure in the supply chain.

II. BACKGROUND

This section illustrates the importance of GPOs in supply chain management, along with the challenges being faced and how we can adopt blockchain technology to ensure transparency in the supply chain process.

A. Advantages and Importance of GPO:

Supply chain management is complex and difficult to manage because of the dynamic relationships among the trading partners. Due to technological advancement, a shortage of products or even entry of new products occurs at a great pace. Hence, an additional obstacle is created due to a lack of consistency and correctness in distributing or ordering the products.

However, most of these issues can be solved while working parallelly with GPO, who get to the bottom of this problem by not only reducing the cost but also bringing effectiveness and consistency in the supply chain process with other advantages which are as follows:

- Depending on the number of providers/ buyers who had a tie-up with GPO as well as the demandof the product, the GPO sets an initial selling price and negotiates with the manufacturer, which would eventually give the providerspurchasing power.
- Due to the interference of GPO, providers no longer need to analyze the supply cost, bargaining price or even brainstorm the custom contracting details. This information is provided by the GPO due to the interlinkage between the manufacturers and the providers. Keeping such statistical data helps the GPO to save costs and refine the supply chain process.
- GPOs not only do data analysis, but they also provide training services to the providers to adapt to new technology by understanding market trends and e-commerce solutions and managing inventory control.
- The most beneficial thing that the GPO offers to the provider is that, whenever there is a shortage of products, the GPO alarm the providers and find them alternative products from different manufacturers in case if there is any concern regarding the product. These things are overlooked by the manufacturers, which would eventually lead to some amount of loss to the provider.

B. Blockchain for Supply Chain Management using GPO:

Traditional supply chain management lacks in various fields, which can be overcome by the interference of GPO. But still, there are certain issues like disparate data systems and lack of transparency between the suppliers and the providers that need to be addressed using modern technology. Moreover, more than 60% of the US population who had their first covid does have concerns regarding the vaccine due to the lack of transparency between the distributor and the consumers, which can be overcome using blockchain technology. Hence, using blockchain GPOs can establish effective collaboration among the stakeholders as well as manufacturers to transfer the data with distributors in real-time, which can update the pricing as well as other changes in the GPO contract, thus saving time and cost. These things are possible for blockchain due to various characteristics it offers such as smart contracts, data immutability, and decentralized and distributed networks.

The decentralized system helps business networks for the instance supply chain to connect in a synchronized manner. Filecoin and IPFS are prime examples of a decentralized storage network. IPFS uses content-addressing to uniquely identify each file stored as a hash. Whereas filecoin sits on the top of IPFS that reduces the chances of getting the user offline. Hence data sharing is made easy since each member in the network or who has signed the contract receives a copy of each transaction. These blocks form a global chain. Miners gain rewards by validating transactions and grouping them while forming blocks. These depend on the

protocol being used which differs from one platform to another. Ethereum uses both Proofs of Work and Proof of Stake. All the transactions that take place in blockchain are non-repudiable and permanent.

Price negotiation is a complex task, however, blockchain makes this process simple with the help of contracts. Whenever a change occurs, these contracts trigger an event thus notifying all the providers.

There are more chances of generating errors while negotiating price, rebates, and GPO administrative fee payments, thus blockchain would be able to address this issue as it is recorded and timestamped so that the providers would be able to know the changes that took place in the contract.

It is a time-consuming task for GPOs to monitor and confirm whether the providers have fulfilled all their demands, thus blockchain allows the GPOs to notify/alert and track the providers with the help of smart contracts as they are programmed in such a way to ensure that all the providers obey the rules and regulations.

III. RELATED WORK

As per the survey conducted by Burns and Lee of different hospital managers, 94% of those are GPOs. This is because GPOs aid in reducing the total product cost such as wholesale prices of different items. GPOs play an important role in cutting down the cost and benefitting the providers amidst the continuous cost growth in health care and different industries. Group Purchasing is often called collaborative or joint purchasing because they collectively negotiate with the stakeholders to offer a negotiable price to their customers.

GPOs reduce overall supply chain costs and limit duplicate purchasing efforts, thus cutting down the transaction cost. Moreover, GPOs have all the statistical data that helps the providers in studying the supply chain market, therefore by studying the market demand and utilizing economics of scale, the GPOs aim to grip the negotiating strength. GPOs give the opportunity for purchasing bulk volumes, lowering demand risk, and sharing resources.

GPOs help in improving medical operations. As per the report, in the US there were no charges applied for the hospitals for the vaccines made available for the children. For adults, vaccines were obtained by the providers through third-party vaccine distributors or Vaccine Purchasing Group. VPG are large organizations that have agreements with different organizations which eventually help in obtaining a favorable cost with increased efficiency.

Challenges faced in SC such as miscommunication, cost savings, lack of transparency, and trust among stakeholders are a certain obstacle in the supply chain process that can be avoided using blockchain technology and GPOs parallelly. Different methods are used to improve efficiency which includes cooperative purchasing, stockless systems, and ecommerce. As per the study conducted by Nollet and Beaulie to know the factors that impact the development of purchasing groups, different factors were identified such as payers' intervention, relationship with suppliers, resource and structure, and procurement strategy. From that, it was revealed that group purchasing is a valuable procurement strategy.

IV. PROPOSED SOLUTION

A Smart Contract based solution that brings manufacturers, distributors, GPOs, and Service providers on the same decentralized platform and can be means of interaction. our solution uses role-based access control methodology and keccak256 cryptographic function to avoid malpractices.

- Manufacturer: A firm that does R&D, develops, and ultimately sells products in bulk.
- Group Purchasing Organization: An organization that purchases goods in bulk from the manufacturer on behalf of multiple service providers thus they can negotiate pays a certain amount from CAF to the service provider such that these amounts can be used in forthcoming Ethereum smart contracts procurement.

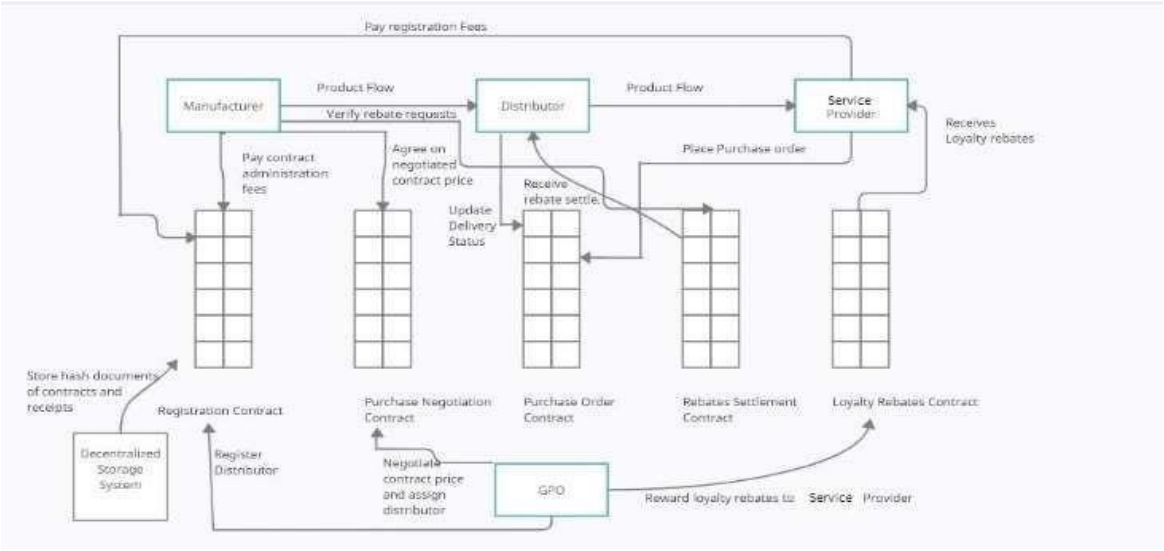

Figure 2. Overview of blockchain-based GPO contract solution using smart contracts procurement.

V. IMPLIMENTATION

- Distributor: The distributor acts as a middleman between manufacturer and service provider, they purchase goods from the manufacturer at a higher price than the negotiated price and are usually claim profits from delivery fees and bonuses from manufacturer after they sell goods to service providers at a negotiated price. Each Delivery partner will be given an Encrypted passphrase using Keccak256 which returns bytes32 key, this key must be used by All delivery partners to hand over the product at different stages of shipping and thus product tracing can also be done.
- Service Provider: They purchase goods from the distributor via GPO and manufacturer, if a particular manufacturer is assigned by GPO then all registered providers in the contract can negotiate the price and providers and get their products delivered at a negotiated price from distributors which is assigned by GPO.
- Decentralized Storage: A network of computers where data is stored on multiple nodes. E.g. IPFS, Filecoin. Storing large data on the main blockchain would be expensive thus data will be stored in IPFS which would be mapped to the chain through indexing.
- Smart contracts: Ethereum is a decentralized blockchain equipped with smart contract functionalities, Terms and conditions of the agreed contract are written in form of a solidity code, these solidity codes would execute on happening of some event within the smart contract.
- Registration: This is the smart contract that is used for registering stakeholders like service providers, manufacturers, and distributors. The service provider has to pay a yearly subscription amount to GPO while the manufacturer pays CAF to GPO.
- Price Negotiation: Procedure of price negotiation for the exchange of goods and services is performed using volume of goods they purchase.CAF is some portion of the negotiated price in the contract. Service providers pay contract administration fees (CAF) to GPOs from which their operating costs are fulfilled. GPOs remunerate service providers with a small amount of CAF for customer retention.

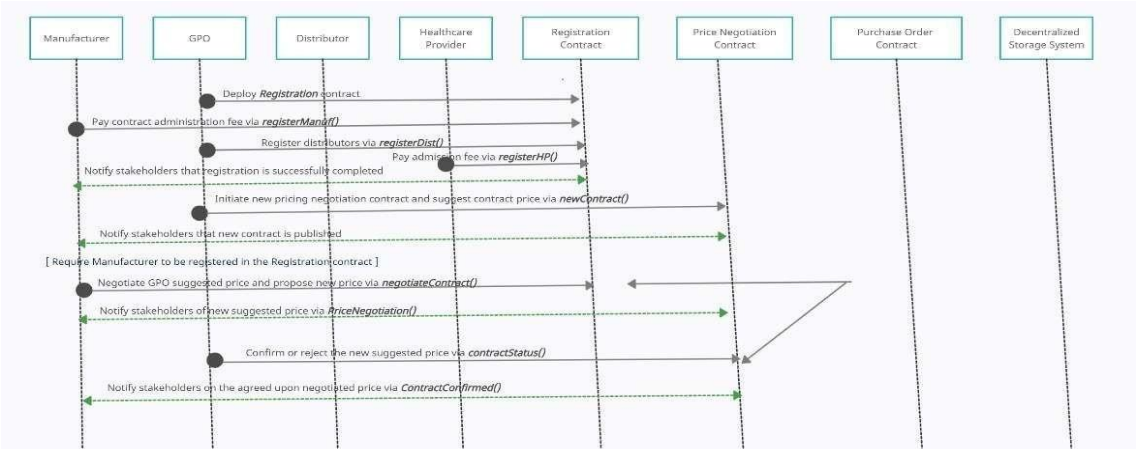

Figure 3. Sequence diagrams of function call and events between stakeholders when initiating GPO contract.

- In this contract only registered members can participate and are bound by role-based access control techniques. If the manufacturer settles for contract price in exchange for a particular volume of goods, then a distributor is assigned by GPO for taking care of the delivery to the service provider.
- Purchase order: At negotiated price providers can place an order via this smart contract, this purchase order is handed over to the assigned distributor, then they send goods to the provider at the agreed price which triggers an event upon delivery.
- Rebate Settlement: Distributor purchases goods from the manufacturer at a higher cost and sells the goods to the provider at a lower cost this loss to the distributor is fulfilled by manufacturer bonus upon successful delivery with agreed term and condition mentioned in the contract.
- Loyalty Rebate: As a part of customer retention GPO Confidentiality: Confidentiality is maintained as the identities of stakeholders would be known through their Ethereum address and by storing data in encrypted format in distributed storage which gives confidence to stakeholders to exchange information in the supply chain thus enhancing transparency.

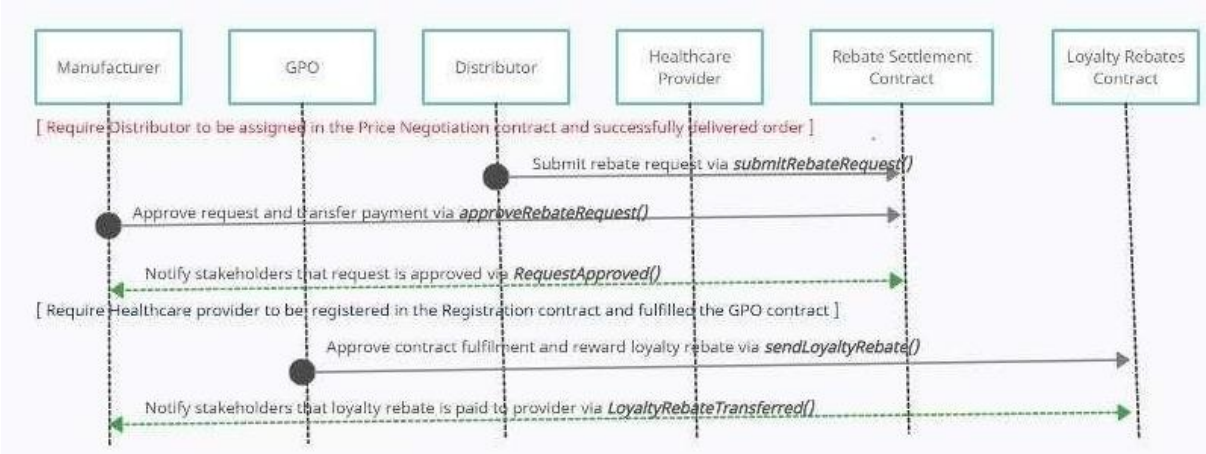

Figure 4. Sequence diagrams of function call and events between stakeholders when claiming rebates

VI. SECURITY ANALYSIS

This section discusses the implementation detail of our 5 Security and privacy in procurement contracts are important smart contracts solution. Each smart contract performs a and this section discusses various aspects like cyberattacks, specific task only. data integrity, etc.

- Data integrity: Any modification of data triggers a new transaction in the Ethereum blockchain thus all history of any sort of modification would be recorded. Accessing a smart contract would require permission which would be implemented by role-based access control methodology (e.g. Only GPO can assign distributor) and keccak256 cryptographic function.
- Non-repudiation: As smart contract executes functions on happening of some event (e.g. Upon delivery bonus amount would be sent to distributor) stakeholders are informed of all transactions thus they cannot deny of payment settlement or order not shipped.
- Cyberattacks: Ethereum blockchain digitally encrypts all transactions by cryptographic hashing, as all blocks are chained together using cryptography, tampering with any block would require a private key or if the block did get tampered it would break the chain and would lead to mining of that block again to validate the transaction.

VII. CONCLUSION

In this paper, we provided an outline of the supply chain contracting system related to multiple stakeholders including manufacturers, GPOs, distributors, and service providers. We explained how the presence of GPOs in the supply chain facilitates numerous stakeholders inside the supply chain, especially the service providers via way of means of accomplishing cost savings from discounts, amount reductions, and operational financial savings because of efficient procurement practices. GPOs additionally offer managerial aid and assist with the dealer qualification process. In spite of major advances in new technologies service providers still suffer from information opaqueness, poor procurement, real-time tracking and process complexity, and so on.

In this paper, we proposed automating procurement contracts in the supply chain integrating blockchain technology and decentralized storage using the Ethereum network enabling transparency, streamlining communication among trading partners, and minimizing the procurement timeline while avoiding pricing

discrepancies and inaccuracies. We have used Role-based access control methodology and keccack256 for comparing keys at delivery partners. We attempt a generic framework with detailed algorithms depicting various interactions among trading partners. The proposed solution ensures that only registered stakeholders are permitted to register and interface with the procurement agreement, guaranteeing trust and straightforwardness among partners. As future work, we proposed to design and build DApps facilitating the entire automation of the alternative associated method for all stakeholders within the Supply Chain. Additionally, our future work extends to managing adaptability issues and viewing as the specific expense of running a blockchain framework in the supply chain.

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