

# Construction DAO for improved project management and stakeholder's engagement

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## Abstract

The Decentralized Autonomous Organization (DAO) is a new form of organisation where the activities and operations are presented on a Blockchain using smart contracts. This article explains the concept of DAO in construction project management by examining the features of DAOs and How they can improve projects workflow. Features like trustless voting and minimising human interaction in project processes include releasing payments, revoking, or granting access to data. DAO concept presents an improved version of traditional organisations with several improvements to increase stakeholders' involvement, reduce delays and track the project performance. The article explores the DAO concept by examining the available DAOs, and it also presents a hypothetical example of possible uses for DAO in construction management.

## 1. Introduction

The construction industry is often criticised for being fragmented and inefficient [1]. In order to overcome these problems, those involved in the construction industry are implementing new technologies such as BIM, IoT and Blockchain to help bridge the gap between construction and other industries [2]. Blockchain applications in construction is a growing field of research where multiple studies are presented to evaluate its capabilities to improve productivity and collaboration. This article presents the concept of Decentralized Autonomous Organization (DAO) for construction-related applications. DAO is a digital organisation structure that replaces traditional organisations with a Blockchain-based one. This article spans over five sections: (1) limitation of traditional management and governance in construction; this section addresses three aspects of limitation of the traditional construction organisation, including governance structure, opportunism in alliances and corruption. (2) Blockchain and Decentralized Autonomous Organization (DAO), where the concept of the DAO is presented in addition to its underlying technology Blockchain. (3) DAOs in Construction where two hypothetical examples are presented for applying the concept of DAO in construction-related activities. (4) Conclusion where a summary of the article content is provided.

Traditional digitalization allowed management at the secondary level to improve its processes and help it perform nimbly. However, digital enterprise systems such as Enterprise Resource Planning (ERP) systems are largely centralized, which limit their functionalities in inter-organization collaboration. Furthermore, upper management still uses the traditional communication channels, especially on inter-organization related operations. These two factors, combined with a fragmented environment such as the construction industry project environment, limit the digitalization benefits. Integrated Project Delivery (IPD) is one of the proposed solutions to reduce fragmentation. However, one of the most prominent characteristics of the construction industry is competitiveness; combining that with a vast number of stockholders, poor resources integration, lack of trust, poor definition of roles and responsibilities are all barriers to reaching the expected benefits of IPD. This article presents the DAO concept and capabilities to help institutionalize collaborative practices in the construction industry where any two parties on any level can create a DAO and use it as a foundation for their collaboration to benefit from the DAO features.

## 2. Limitation of Traditional Management and Governance in Construction

Construction endeavours are unique from endeavours taken by other companies. The reason behind that is the non-standardised construction projects nature where each project's goals are different from another [3]. Moreover, construction is a project-based industry which makes it more fragile compared with products-based industries. Traditional Construction management and governance accumulated several

problems and limitations that hampered it from catching up with other industries. These issues are further explored below.

## 2.1. Rigid Corporate Governance Structure

Construction companies are composed of two controlling bodies: (1) the board; and (2) the managers. The board role is to provide governance for the company by evaluating the management team performance, rewarding them for good results and executing reprimand actions to correct their behaviour. The managers, on the other hand, take control over the day-to-day tasks and take control over the company operations. The two bodies structure was created to ensure that the interests of shareholders are protected against poor management behaviour. A study by Rebeiz and Salameh [4] investigated the relationship between the construction companies and the financial performance of these companies. The study shows the complicated relationship between the boardroom and the managers in aspects: (1) boardroom independence from management; (2) leadership structure; (3) size of the board; (4) board committees; (5) the frequency of the board meetings. There are two leadership structure models; the first one is the joint structure where the CEO position and the board chairman position are occupied by one person [5]causing internal congestion of indecisive and/or unsuccessful projects. This research empirically scrutinizes project portfolio success in a transnational and cross-cultural perspective in the Asia-Pacific (APAC. The second model is the separate structure model where the position of the CEO and board chairman are occupied by two different people. Each of these models has advantages and disadvantages; for example, when the joint model is applied, there is no ambiguity regarding the company priorities as one person leads both controlling bodies. However, one leader for both bodies results in a concentration of power, making it harder to ensure corporate accountability. It also makes it hard to challenge the CEO decisions. On the other hand, the separate model encourages technocracy, where each board member has duties and develops expertise, resulting in stronger board governance. However, the strong-minded board can cause a longer decision-making process because of the prolonged negotiations between management and the boardroom.

## 2.2. Opportunism in Construction Alliances

Forming alliances and partnering is one of the construction management strategies used widely in the construction industry. Partnering increases the construction companies' capacity to handle large and sophisticated tasks [6]. There are two types of partnerships: (1) cooperative and (2) competitive partnerships. A client partner with a contractor to design and build a house is considered a cooperative partnership because the client and the contractor are not in direct competition. On the other hand, when two contractors form an alliance, they are in a cooperative and competitive partnership because they are in direct competition as they both target the same market. An alliance is defined as a voluntary agreement involving two or more companies to take a project in order to develop it together. This agreement includes

details about the procedures for information, products, technologies and services shared during the period of the alliance. While partnering is encouraged between contractors, it requires trust between partners. Indeed, each partner's vulnerabilities are exposed during the partnership period, such as the limit or quality of resources available. Besides, even though a group of contractors are in an alliance, they are still competitors in other projects, which raises the risk of opportunistic behaviour, leading a partner to exploit the partnership to their benefit [3].

### 2.3. Corruption in Construction

The construction industry's corruption levels are the highest amongst the activities covered in the global corruption report [7], where the procurement sector had the highest number of incidents. Corruption lowers work efficiency and increases inequality. Several studies investigated corruption in construction. Owusu et al. [8] presented a framework for anti-corruption measures. The framework categorises corruption combating measures into six groups: (1) Regulatory measures, such as the use of ethical codes. (2) promotional measures, for instance, increasing accountability, access to information, and enhanced communication. (3) reactive measures; an example of that is punishment and penalties. (4) compliance measures, for example, contractual and procedural compliance. (5) probing Measures, including rigorous auditing system, contract monitoring, and an efficient reporting system [8].

## 3. Blockchain and Decentralized Autonomous Organization (DAO)

Decentralised Autonomous Organisations (DAO) or Decentralized Autonomous Corporation (DAC) is an emerging form of management style where advancement in information technologies is leveraged to achieve self-automated governance [9]. The concept itself is an evolution of the Cyber Movement organisation (CMO) [10] concepts combined with the Distributed Artificial Intelligence (DAI) systems. CMO refers to a group of people who formed an Internet-based gathering to discuss or lobby online for a certain topic. DAOs try to reduce the costs of acquiring information, management, supervision within an organisation by creating an effective governance mechanism by leveraging Blockchain technology features such as decentralisation and immutability, ensuring data auditability and integrity. These features allow for creating and transferring digital assets safely and effectively. Blockchain is a digital data handling technology that allows users to store and exchange data in the form of transactions stored in an immutable and auditable ledger called a Blockchain. A DAO can be defined as an organisation that runs on a Blockchain to achieve decentralised governance and management by leveraging Blockchain smart contracts features to accomplish the organisational goals. According to Wang et al. [11], DAO Characteristics are: (1) decentralised and distributed organisation, decentralised refers to the absence of the traditional organisation hierarchy for decision-making purposes. Distributed refers to the use of a nodal network system to exchange and store the DAD smart contracts and DAO members identities. (2) autonomous and automated, which

refers to the ideal DAO situation where the code is the law which means consensus is reached automatically and autonomously based on the smart contracts, which removes bureaucracy for the standardised procedures. Furthermore, the power of decisions is distributed instead of being concentrated in a few individuals' hands. (3) organised and ordered: the DAO operational procedures are written in the smart contracts, including rights and obligations of the DAO members, which ensure applying the reward or penalty, when necessary, which make DAOs constantly transparent and in order.

Examples of currently fully operational DAOs are limited. Two use cases are provided: (1) The DAO [12] established in 2016 was the first realisation of the DAO concept. It was built as a venture capital DAO on the Ethereum public Blockchain. The DAO collected \$150 million of the Ethereum native cryptocurrency ETH. The DAO was managed through a smart contract. The money was collected as crowdfunding Initial Coin Offering (ICO). People who participated transferred ETH from their wallets to the smart contract, which then sent them the DAO token, which represents their shares in DAO. In addition to that, the received token represent their voting power when voting on funding proposals. The DAO suffered a major security breach where a hacker took advantage of a bug in the smart contract, which resulted in the DAO to defunct. (2) Constitution DAO [13] was established in 2021 when a group of crypto investors formed a DAO to collect enough money to bid on a first edition copy of the United States of America constitution auctioned at Sotheby auction house. The Constitution DAO managed to collect \$47 million worth of Ethereum within a week and ahead of the auction. The Constitution DAO formed a corporation to represent it in the auction because DAOs are currently not considered a legal entity. The constitution DAO was outbid in the auction. Therefore, they did not manage to obtain the auctioned constitution copy. The Constitution DAO investors were allowed to get money back minus the transaction through the project smart contract.

DAOs are still in an early adoption stage; therefore, they face challenges. These challenges include security, legal, and technical challenges. Security challenges refer to the limited understanding of smart contracts writing skills which could cause security problems leading to breaches like the DAO breach. Legal challenges include the traditional institutions' recognition of this type of organisation. Technical issues include privacy, performance, and flexibility.

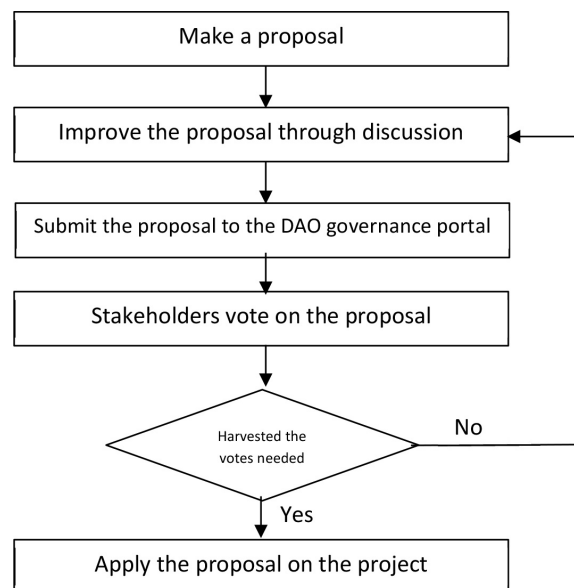
## 4. DAOs in Construction

The DAO concept could be applied to construction companies and projects to improve collaboration, owners' involvement, citizen engagement, and resource sharing. DDAOs can be divided into two categories depending on the underlying smart contracts: (1) basic DAOs where the smart contract does not require off-chain information to function properly. (2) advanced DAOs where the smart contracts require an off-chain source of information to function properly. In order to clarify this, two

examples are provided in this section: (1) Stockholder's governance DAO as an example on basic DAOs; (2) Resources pooling DAO as an example on Advanced DAOs.

#### 4.1. Stockholders' governance DAO

Construction project stockholders represent a group of people who share the interest in a project path to ensure their interest is protected from other stockholders' opportunistic behaviour. A governance DAO uses Blockchain technology and smart contracts to archive frictionless relationships between the project stockholders. In addition to that, the governance DAO log is recorded on the Blockchain, which makes its events auditable. An example of governance DAO in construction is a governance DAO for a new airport project. Such a project has many stakeholders with different interests, including airlines working in the city, the city council, the environmental assessment committee, local citizens and candidate contractors. Governance DAO offers fair governance and minimises opportunistic behaviour from stockholders. The stockholders' power in such DAO is represented using two types of Blockchain tokens: (1) fungible tokens, which are a digital representation of voting rights distributed on stockholders according to their voting in the DAO. (2) Non-Fungible Tokens (NFT), which are a digital representation of special voting rights where each NFT has unique attributes representing their unique voting powers. NFTs are Blockchain-based assets designed to be unique by their attributes and can resemble ownership or authenticity letters verified on the Blockchain. An example of unique voting rights from Airport Governance DAO is the environmental assessment committee, where the committee is responsible for choosing locations with respect to the results of the environmental assessments report. Therefore, the power of an investor represented in the fungible tokens in their wallet is negligible in this aspect. However, another aspect, such as the winning airport design, is chosen through fungible tokens Votes proposal. The dual tokens governance structure allows for higher flexibility without compromising any stakeholder authority. Figure 1 shows the business logic of Stockholders' governance DAO.

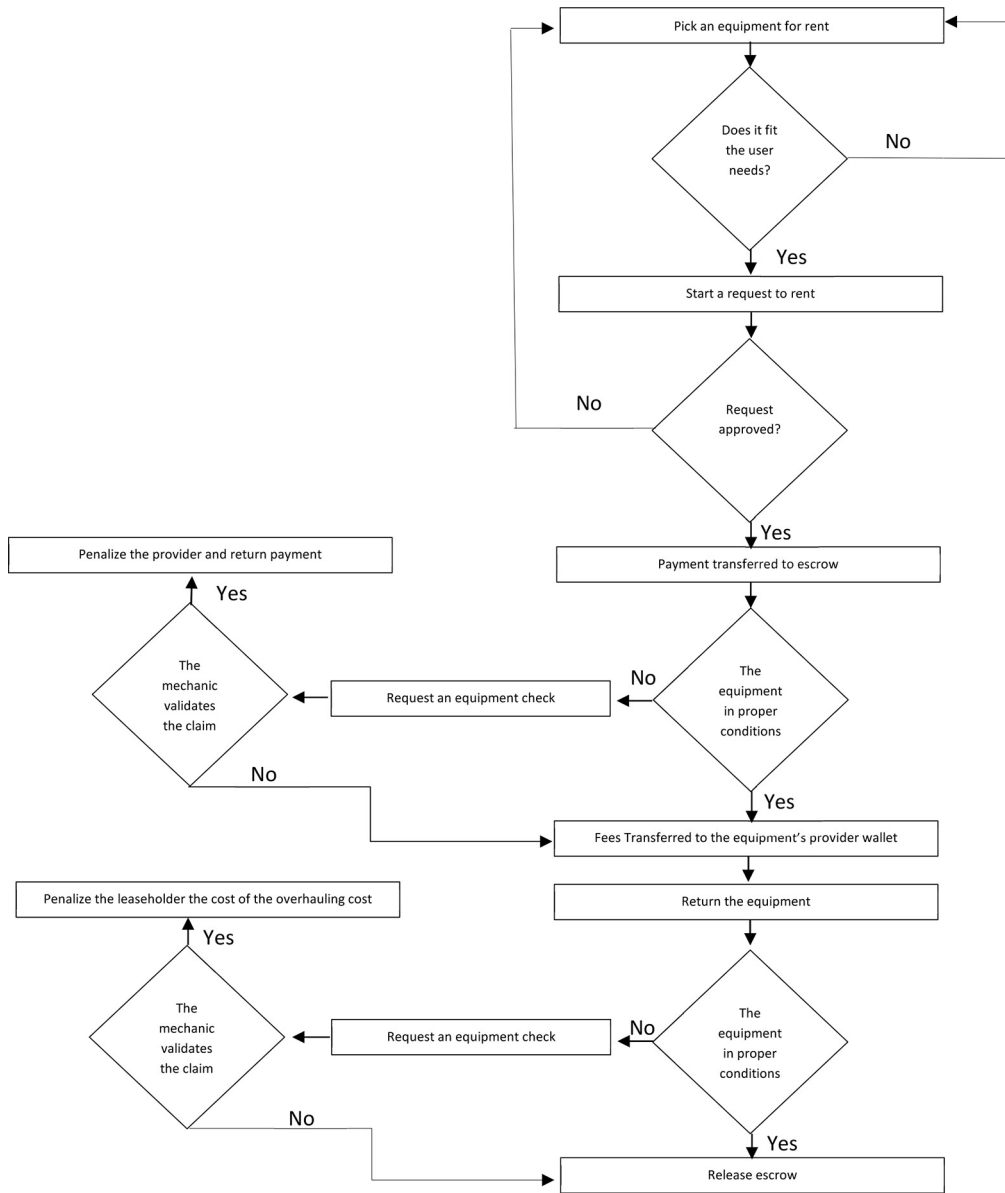


**Figure 1**  
The business logic  
of Stockholders'  
governance DAO.

## 4.2. Construction Collaborative DAO

The ultimate goals for DAOs are to save costs and improve governance. Information collecting costs, work coordination fees, and supervising work costs are examples of such costs. DAOs can achieve these savings by automating tasks and procedures. DAOs are characterised as automated and autonomous where the code is responsible for tasks execution without a centralised authority where there is no unbalanced power distribution because the centralised authority is replaced with rules and defined patterns, which results in minimising the management costs, middling costs, and saving time by avoiding bureaucracy.

An example of collaborative construction DAOs is resource pooling DAO. This DAO allows construction companies to share equipment and tools for an exchange of money or a mutual collaborative sharing agreement. Such a DAO can provide a detailed record of each piece of equipment, including its mechanical inspection reports, maintenance schedule, current location, fuel level, work schedule. This information allows contractors to borrow equipment without the need to go through a manual bureaucratic repetitive process. In addition, providing a detailed history of the equipment protects both parties; for example, a contractor can avoid renting with complicated mechanical history or upcoming maintenance. Also, contractors can avoid moving their equipment over long distances if they can find a nearby competitive option. However, this type of DAOs requires an off-chain source of information or what is known as a Blockchain oracle to feed the information needed for the smart contracts to function properly. In the case of this example, each piece of equipment requires a Decentralised Identifier (DID), an instrument used to identify a person or a thing in a Blockchain-related process. The DID of equipment will be connected to the information related to the equipment, such as owner, location, and availability. Also, the external performers, such as mechanics who do the inspection for equipment will have a DID where participants can track their record of work. Contractors or equipment providers participating in this DAO are identified using their digital Blockchain wallet connected to the smart contracts. The equipment is added as a Non-Fungible Token (NFT) to the owner. Figure 2 shows the business logic of the proposed construction collaborative DAO.



**Figure 2**  
The business logic of the proposed construction collaborative DAO.

### 5. Conclusion

The construction industry adoption of digitalisation and information technology tools has helped in boosting its performance by encouraging collaboration and improving data utilisation. However, several aspects of the industry remain fragmented and vulnerable. This article discussed three of these aspects: poor governance, opportunism in collaboration and corruption in construction. While these aspects pervasively affect the construction industry, Blockchain-based organisation management seems like a good fit for such problems.

The study introduced the DAO in construction and the possibility of incorporating it in construction practices to improve the construction management and technology synergies.



The DAO concepts can replace the rigid governance model of construction organisations with a dynamic governance model where roles are flexible with a balanced distribution of power. The DAO also can change how organisations share information and collaborate when forming a construction-related alliance. Blockchain, in general, was introduced in several studies as a corruption combating method. The DAO concept represents one of the methods where Blockchain can play a key role in reducing corruption in construction practices by implementing rigorous auditing systems and live contract monitoring.

It is important to understand that the DAO is not meant to totally replace the traditional governance structures but to improve how they collaborate with each other by introducing a powerful digital management platform. DAO governance platforms, when developed properly, provide participants with transparent management experience with highly defined roles and responsibilities which should encourage participants to use it to prove they are doing their share of responsibilities.

The article presents two hypothetical DAOs. The first is the stockholders' governance DAO, which shows an example of an airport project governance protocol using Blockchain technology. The second example illustrates a collaborative construction DAO, an advanced DAO, which refers to the use of Blockchain in addition to other technologies, such as the Internet of Things (IoT).

The concept of DAO in construction is promising. However, further research is required to develop a deeper understanding of smart contracts, a fundamental part of DAOs. DAOs currently lack legal recognition. Nevertheless, they could be implemented as additional governance measures to increase transparency in construction companies and projects.

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