



# Blockchain Governance Design a Computer Science Perspective

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**Abstract.** Blockchain-based DAOs and governance frameworks have emerged, however limited research has been done on the governance foundations of blockchain networks. In blockchain networks decisions are made through a collaborative and consensus building design mechanism. Such a governance process is complex, dynamic, and challenging. This paper presents blockchain governance design from a computer science perspective. We do so by exploring concepts such as decentralization, blockchain governance, Decentralized Autonomous Organization (DAO) and a novel modeling approach on blockchain governance namely DECENT. In this paper, we presented why conceptual modeling is a design requirement for blockchain governance. Researchers can use the DECENT modeling approach as a reference framework for blockchain governance design, such as empirical and comparative case studies.

**Keywords:** Blockchain Governance · DAO · Digital Platform Governance · Decentralized Governance Design

## 1 Introduction

Decentralization has been a growing trend in recent years, with an increasing number of entities moving from centralized towards decentralized systems [2, 4, 19, 26]. Kaya et al. define [18] decentralized governance (DG) as a collection of parties who work cooperatively and competitively to satisfy customer needs, and in which decision power is fairly distributed over a (sub)set of parties in the ecosystem [1, 10]. This approach has several potential benefits [8, 13] and we can consider decentralization and the emergence of DG as a response to the limitations of centralization and the need for a more flexible and adaptable ecosystems. Blockchain technology can be seen as an important driver in the conceptualization and adaption in the field of decentralized governance [25, 26]. Along with the development of blockchain technology, the idea of web 3.0 as a new iteration of the World Wide Web is proposed<sup>1</sup>. Web 3.0 aims to build a more open, decentralized and user-centric internet [6]. Blockchain network governance, which also can be seen as decentralized governance, involves decision-making and resource allocation through a decentralized network of participants, this is a key feature of Web 3.0. Although many

<sup>1</sup> <https://www.wired.com/story/web3-gavin-wood-interview/>.

blockchain-based DAOs and blockchain networks have emerged, very limited research has been done on the theoretical foundations and model validation of the decentralized ecosystem design [7]. Also, current blockchain networks still face issues in the actual implementation process [12, 29]. Our long term research goal is to develop a domain specific language (DSL) for DECENT, that allows a systematic approach in designing decentralized governance for blockchain networks. The research goal of this paper is to present blockchain governance design from a computer science perspective.

This paper is structured as follows. In Sect. 2, we explain our research approach. Section 3 presents conceptual modeling to design blockchain governance, Sect. 4 presents our conclusions, limitations, and suggestions for further research.

**Table 1.** Research Selection Criteria

Pub Year	Keyword Selection Criteria	Reference
2011–2018	DACs, DAOs, Blockchain, Design principle	[1, 4, 9, 10]
2019–2021	Model construction, DGD frameworks	[8, 11, 13, 16–18, 25, 26, 29]
2022–2023	BGD, Conceptual modeling	[2, 3, 5–7, 12, 15, 21, 23, 24, 28]

## 2 Research Approach

The research goal of this paper is to present blockchain governance design from a computer science perspective. We do so by exploring the concepts and developments of blockchain networks, DAO and conceptual modeling. We selected the PRISMA methodology [20] as our research approach. Research question and detailed steps are presented as follows:

### **RQ: Why is Conceptual Modeling Relevant for Blockchain Governance Design (BGD)?**

**Step 1 - Identification.** Our preliminary study starts with publications presented by DISE lab<sup>2</sup>. We searched literature by keywords like DG, DAO framework, blockchain governance, conceptual modeling and the ‘snowball’ method [27] is applied. As BGD is an emerging research domain we cannot only limit ourselves to google scholar, but also focus on relevant websites, conference, white papers and reports. The total number of retrieved literature records is 1645.

**Step 2 - Screening.** Our research domain is focus on the computer science perspective. Records discussed from a economic, business or political perspective are excluded. We screen these literature records mainly by abstract and keywords. The number of records excluded in this part is 649.

<sup>2</sup> <https://dise-lab.nl/>.

**Step 3 - Eligibility.** The number of remaining literature records after being assessed for eligibility is 97. We keep 29 records closely related to the area of DG, DAOs framework, meta governance design and co-area of conceptual modeling and blockchain governance design.

**Step 4 - Included.** We analyzed 29 literature records ultimately. After indepth reading and critical understanding of the selected records, we can answer our research question. Research selection criteria are summarized in Table 1.

### 3 Conceptual Modeling for Blockchain Governance Design

#### 3.1 Blockchain Networks in DAO Design Philosophy

In this section, we first discuss blockchain networks that employs a DAO design philosophy which contains the concept of decentralization. Also, some design flaws has been identified and summarized. Secondly we present DECENT which is a novel and innovative conceptual modeling approach for blockchain governance design (BGD).

#### **Blockchain Governance Networks.**

In this subsection, we discuss many blockchain-based DAOs and blockchain networks in DAO design philosophy and identified some design flaws from them. *Compound*<sup>3</sup> is a decentralized financial (DeFi) platform which key feature is loan rates are automatically adjusted. Decisions in Compound are made via smart contracts, and token holders have governance rights. [12].

*Uniswap*<sup>4</sup> is the largest decentralized exchange (DEX) platform allowing users to trade crypto currency tokens without intermediaries [12], but its decision making structure is still centralized.

*Ethereum Name Service (ENS)*<sup>5</sup> is a decentralized domain name service system, which is more decentralized compared to Compound and Uniswap [12].

*Aragon*<sup>6</sup> is a DApp that facilitates the creation and management of DAOs. It provides a modular governance framework while this framework does not provide a governance coordination mechanism [11].

*MakerDAO*<sup>7</sup> is a DeFi project combines functions from voting to execution and issuing governance passes [5]. Due to off-chain coordination mechanism, it suffers from the inevitable drawbacks like progressive centralization of governance, increased governance costs and reduced governance initiative of participants<sup>8</sup>. *Moloch DAO*<sup>9</sup> is a governance framework emerged to crowdfund and allocate funds for Ethereum infrastructure projects. Moloch DAO V2 adds a multi-pass system and many mechanisms

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<sup>3</sup> <https://compound.finance/>.

<sup>4</sup> <https://app.uniswap.org/>.

<sup>5</sup> <https://ens.domains/>.

<sup>6</sup> <https://aragon.org/>.

<sup>7</sup> <https://makerdao.com/>.

<sup>8</sup> <https://makerdao.com/zh-CN/whitepaper/>.

<sup>9</sup> <https://dao.molochdao.com/>.

which has improved the degree of distribution and governance stability while problems like malicious proposal attacks and the long governance decision cycle still existed.

*DAO stack*<sup>10</sup> aims to solve the scalability problem in governance and focuses on effective distributed decision-making through its proposed Holographic Consensus decision system<sup>11</sup>.

**Design Flaws.** There are many design flaws existed in blockchain governance networks: (1) Difficulty in balance between decentralization and efficiency. Competing points of interest for different stakeholders can lead to decision-making bottlenecks and inefficiencies [3, 7]. (2) Incomplete decentralization. Many ecosystems claiming decentralization do not achieve it in practice, and decentralization should extend to processes preceding governance decisions [12, 15]. (3) The issue of scalability. The underlying blockchain technology limitations [22] can lead to scalability issues as usage grows, resulting in slow and expensive transactions [21]. (4) Application scenarios and function of blockchain network governance are limited. Limited exploration of real-life scenarios with disintermediation and distributed requirements [7], and a lack of new modules on governance framework platforms restrict the overall governance efficiency and quality [24].

(5) The potential legal risks [9, 28].

### 3.2 Conceptual Modeling Method

Blockchain governance design (BGD) is clearly an emerging research domain and it has been identified that there is a need and requirement for a conceptual modeling method which allows to design blockchain governance [8, 23]. A conceptual modeling approach is a method used to design and represent complex systems in a simplified approach. In the context of BGD, conceptual modeling is useful as it can be used to design and represent complex, decentralized systems for DAOs that is easy to understand and analyze. This contributes to identify potential problems or issues with the design and to determine how it can be improved [16] already at an early stage. Conceptual modeling can represent the governance structure and the design decisions of a DAO as a set of artifacts and their inter-relationships. These artifacts can include elements such as decision-making mechanisms, regulations and incentives. In this way, it is possible to understand how the different artifacts interact and how it contribute to the overall functioning of the organization. A novel and innovative approach to design blockchain governance has been recently introduced by taking a conceptual modeling approach. This method to design blockchain governance is coined as DECENT [16].

**DECENT Introduction.** Kaya et al. states that finding an appropriate sound governance solution for a decentralized ecosystem is a design problem [17]. Due to the different application fields and environments of ecosystems, from the perspective of model development, they face different contexts, and the required system components will also be different. In order to avoid serious problems such as centralization of the system, low efficiency or loss of fairness the governance structure can be conceptualized in a clear

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<sup>10</sup> <https://daostack.io/>.

<sup>11</sup> <https://medium.com/daostack/holographic-consensus-part>.

approach that is understood by every actor in the decentralized ecosystem. In order to explore the topic of DGD, authors have founded “DECENT” [15, 16] and presented in Fig. 1. DECENT<sup>12</sup> is developed with the vision that it is a societal and economical responsibility to create ecosystems that promote equity in how we set the rules of participation. DECENT is a conceptual modeling method that will allow an actor or a group who is not proficient in programming languages or technology to conveniently and easily design an ecosystem collaboratively. DECENT employs a conceptual modeling approach, and this type of an approach (machine-processable formalization) will enable the idea of a decentralized ecosystem to be more widely disseminated and applied. For different decentralized projects, the resulting proprietary decentralized governance model will be considered the product of a rigorous design process [17]. DECENT is positioned within the generic modeling method framework as proposed by [14]. DECENT can be used to describe specific governance models, i.e. conceptual models. All governance models are based on real-life research subjects, which can be seen here as abstracted and aggregated from requirements analysis in specific domains such as DeFi, P2P Energy, and Decentralized Social Media.

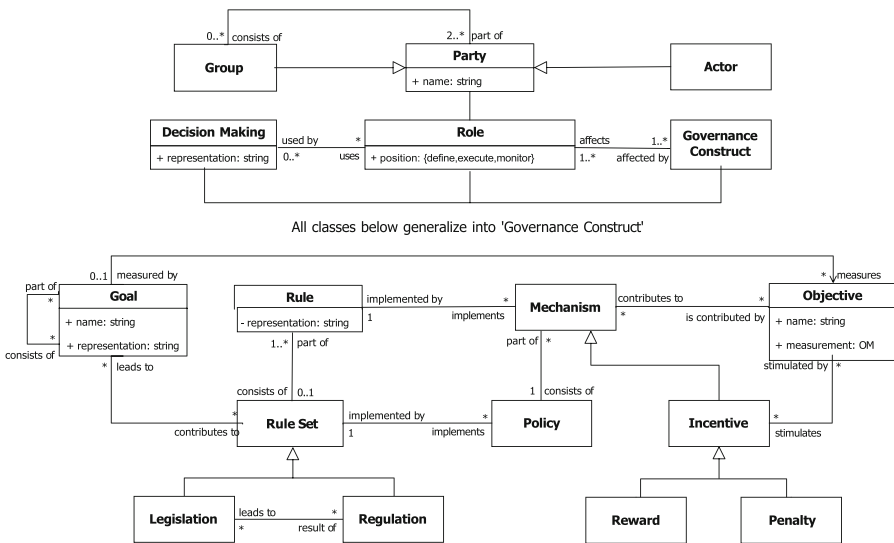


Fig. 1. DECENT meta model [16]

**DECENT Meta Model.** Kaya et al. positions and presents the relevant design artifacts for decentralized governance as the DECENT meta model [15, 16]. DECENT is lightweight and easy-to-handle with a well-defined set of decentralized governance concepts. It responds to the design needs of developing governance structures and aims to provide an easy-to-understand modeling environment and tools for users having the desire to design and build a decentralized ecosystem. Figure 1 shows its meta model as

<sup>12</sup> <https://dise-lab.nl/>.

a UML class diagram, consisting of attributes, associations, generalizations (is-a) and constraints. The DECENT meta model provides a clear and structured approach to defining governance structures and relationships. An important aspect of the DECENT meta model is the multiparticipant approach, which differs from a single participant involved in coordinating system decisions and operations. Each participant has a specific role to define, implement and monitor, and these roles constrain each other, influence each other and complete the whole process of governance design decisions under the influence of other institutional rules.

**DECENT Governance Models.** The DECENT governance model belongs to the domain of conceptual models and can be seen as a bridge between the real world and the DECENT meta model in the overall meta modeling approach [14]. Governance consultants are expected to use the DECENT modeling language as a descriptive tool to conceptually decompose and abstract real-world study subjects (banking, social software, etc.) according to the context and characteristics of the desired decentralized ecosystem in order to present a concrete, specific DECENT governance model. Decentralized governance as a new field of research has not yet emerged as a unified, authoritative definition. Process of multiple participants working together to understand rules and create rules is called decentralized governance, and it is positioned as a design product. The study of BGD by adopting a conceptual modeling approach contributes to the understanding and design of structured governance and unification across industry and as a research domain.

## 4 Conclusion

This paper on blockchain governance design contribute to a perspective for thinking about the development direction and quantitative criteria of future blockchain network governance design in a novel conceptual modeling approach. The development of internet technologies has driven the field of decentralized governance from theory to practice, with the emergence of many blockchain-based DAOs and blockchain networks in DAO design philosophy. Some design flaws could be identified from them. Finding the most adapted governance solution for decentralized ecosystems in different application domains and environments is a design problem, and DECENT employs a conceptual modeling approach to provide a useful solution for analyzing, discussing and developing a reference framework and structured foundation for blockchain network governance. DECENT has already been applied in the domains of peer-to-peer energy trading and digital currency development [15, 16]. A conceptual modeling method helps to identify potential problems in decentralized ecosystem design and determine how to improve them already at an early stage. Also it can be understood and applied by every actor with no reliance on the technology provider to prevent powerful concentrations in developing the governance decision structure. Since our long-term research goal is to develop the DECENT modeling language, we provide a detailed description of the DECENT

establishment concept and the metamodel built according to the conceptual modeling approach (Sect. 3.2).

**Limitations.** The sources we have selected are mostly related to computer science. We excluded sources from a business and political perspective and this can potentially affect the generalizability of our results.

**Future research.** Blockchain network governance requires further exploration from a theoretical foundation and technical development perspective. We will contribute to the design philosophy of DECENT by extending it towards a domain specific language (DSL).

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