On the Alignment of DAO with Socio-political principles of Decentralised Governance using TOGAF and ArchiMate

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Abstract. In this work, we explore the application of Enterprise Architecture (EA) frameworks, specifically TOGAF and ArchiMate, to model the alignment between socio-political artifacts and technological artifacts within Decentralised Autonomous Organisations (DAOs). DAOs are new organisation model that leverages blockchain (BC) technology to implement decentralised governance such as Liquid Democracy (LD) which respect anarchist principles. However, the challenge lies in demonstrating the traceability between socio-political governance processes and the technological artifacts that enables these processes. This paper addresses this gap by applying Design Science Research (DSR) methodology to develop a reference architecture. This Architecture serves as a structured model to analyze and verify the alignment of decentralised governance processes with their technological implementations DAOs. This work contribution is a systematic approach to modelisation and analysis of socio-political structures of decentralised organisations, ensuring they align with the underlying technology supporting them.

Keywords: blockchain · enterprise architecture · enterprise modeling · TOGAF ADM · organisation on Networks · anarchism

1 Introduction

Since Satoshi Nakamoto released the bitcoin whitepaper [39], a new era of decentralised systems began. Initially a peer-to-peer electronic cash system, Blockchain Technologies (BCT) evolved significantly with the Ethereum project [5], introducing Smart Contracts and decentralised Autonomous organisations (DAOs) supporting enterprise use cases. Yet Nakamoto's initial vision, rooted in the cypherpunk movement, aligns with the anarchist idea of a decentralised society.

The anarchist movement, championed by thinkers like Kropotkin [34, 35], Bakunin [4], and Malatesta [36], proposes principles aimed at avoiding exploitation and fostering harmony. However, these principles have never been imple-

mented at scale. DAOs embedding anarchist principles appeal to activists, technologists, and communities seeking autonomy, offering transparent, secure, and efficient ways to manage organisations without central authority, such as Liquid Democracy (LD), proposed in the early 21st century, combining elements of Direct Democracy and Representative Democracy [9, 17, 41].

Direct Democracy, central to anarchist principles, faces issues like voter fatigue and scalability. LD addresses these issues by allowing voters to either vote directly or delegate their vote [9, 17, 41] to others. Thus, LD helps implement anarchist principles in DAOs by reducing hierarchical control and promoting cooperative governance.

To systematically reason about the alignment of DAOs using LD with anarchist principles, we turn to Enterprise Architecture (EA) and Enterprise Modeling (EM) frameworks. Traditionally, EA/EM frameworks demonstrate and analyze the alignment between technology and organisational strategy. They provide tools and methodologies to model enterprises and align business processes with technology. However, little research addresses the alignment between sociopolitical and technological artifacts in decentralised organisations like DAOs.

In this work, we address the following research problem: *How can sociopolitical artifacts for decentralised organisations be addressed by Enterprise Modeling?* We use the TOGAF standard[1] to explicitly reason about processes of decentralised organisational governance grounded in anarchism. We specify the business, application, and technology layers of DAOs and LD using ArchiMate. We use Design Science Research Methodology to create an architectural artifact using TOGAF ADM and ArchiMate.

The remainder of this article is organized as follows: In Section 2, we discuss the main concepts used in this study and present the related works; in Section 3, we present our research methodology and discuss the created artifacts in Section 4; in Section 5, we empirically evaluate the alignment of our artifact with anarchist society principles and provide recommendations for adapting EA frameworks to decentralisation. In Section 6, we provide our conclusions.

2 Background

2.1 Smart Contracts and DAOs

Smart Contracts, first introduced by Nick Szabo in 1994 [50], are protocols for validating the conditions of a legal contract between parties. They execute, control, and document events automatically according to the agreement's terms [32, 55]. Embedded within the blockchain, Smart Contracts are immutable and transparent.

DAOs are organisations operating based on rules encoded as Smart Contracts [23, 52, 53]. They function without human intervention, leveraging blockchain's transparency, immutability, and decentralisation. Key characteristics of DAOs include: *decentralisation*: Operate without centralized authority, distributing

[1] https://www.opengroup.org/togaf

decision-making power among members. *Autonomy*: Smart Contract code governs operations, executing decisions and transactions automatically. *Transparency*: All transactions are recorded on the blockchain, making them auditable by anyone. *Programmable Governance*: Rules and protocols embedded within the Smart Contract automate governance. *Community-Driven*: Governed by members holding tokens that represent voting power, with decisions made by consensus.

DAOs have various applications, such as decentralised Finance (DeFi), collective ownership, investment funds, charitable organisations, and decentralised governance. They can be categorized into: 1) *Algorithmic DAOs*, which defer entirely to software to structure and coordinate social interactions, and 2) *Participatory DAOs*, which emphasize active community participation in decision-making [53].

This work focuses on Participatory DAOs, specifically decentralised Autonomous Communities where each member has one vote, and decisions require a $\frac{2}{3}$ majority [5]. We plan to use Liquid Democracy as the decision-making process in our system.

2.2 Liquid Democracy

Liquid Democracy combines elements from Direct Democracy and Representative Democracy [17] [9] [41]. In LD, voters can either vote directly on issues or delegate their vote to a trusted party. This delegation can continue through multiple levels until the vote reaches a well-informed party, a process known as *"Meta-delegation"*. Additionally, voters can recall their vote at any time. Members can choose on which topics to vote directly and which to delegate. *"Issue-based delegation"* allows voters to delegate their vote for a specific topic while voting directly on sub-topics. LD addresses issues in Direct Democracy, such as voter fatigue and uninformed voters, and in Representative Democracy, such as lack of accountability(e.g: in most Representative Democracy, elected members only handles 1-2 subjects and is incompetent in the others. While voting on a subject the member don't know specifically about he can only vote for a solution he only have vague idea of. Also in this mode, the important is to win the vote and not taking the right decision or being aligned with the social body will) and minority rule(e.g: in organisation that prefer stability and coherence of choices an entrenched minority can take the power). LD was notably used by the Pirate Party in Germany, but the experiment failed when combined with Representative Democracy [9]. Issues like the concentration of power among a few agents and the emergence of super-voters remain concerns. To address these, proposals include *"Multiple Delegations Options"*(i.e: helps avoid super-voter by allowing users to specify several potential delegates instead of just one on various criteria), *"Dynamic Redistribution"*(i.e: system's ability to distribute votes or influence among delegates to maintain a balanced representation to avoid the concentration of votes), and *"Algorithmic Balancing"*(i.e: using using mathematical models and computational techniques to optimize the delegation process) to distribute voting power more equitably [21]. This work explores the use of LD in DAOs to enhance decentralised governance.

2.3 EA Frameworks

Enterprise Architecture is defined as *"the underlying principles, standards, and best practices according to which current and future activities of the enterprise should be conducted"* [46]. According to Fischer [16], EA involves *The Fundamental organisation of a System*, describing system components, their relationships, and their interaction with the environment, and *The Principles Guiding its Design and Evolution*, governing the design, implementation, and development of the architecture, ensuring alignment with business goals. Several EA frameworks and tools are widely acknowledged in the literature [2, 28]. The Open Group Architecture Framework (TOGAF) [27] is a comprehensive method and set of tools for developing an enterprise architecture. ArchiMate [28] is a modeling language part of "The Open Group," used to model enterprise architecture. Zachman Framework [54] defines a 6x6 matrix providing a structured approach to defining an enterprise from multiple viewpoints. FEAF (Federal Enterprise Architecture Framework) [25] originates from the US Federal Government. It integrates business and IT aspects of an enterprise. The Gartner Framework [48] Focuses on EA process development and governance.

To explore whether DAOs using LD can achieve an anarchist society organisation, we use TOGAF framework and Archimate modeling language to model and verify our system. Because first TOGAF is a widely adopted and battle tested framework, helps to define the EA from multiple viewpoints, it has a comprehensive and structured methodology to develop EA, ArchiMate bring modeling capabilities that complement very well the TOGAF ADM.

2.4 Related Works

For this section, we conducted a literature review [2] covering 251 articles, to which we added 5 pre-identified relevant articles. After reviewing each, we isolated 19 related works. These were classified into two clusters: 1) EA for sociopolitical artifacts/E-Government (7 articles), and 2) EA for BC or DAO (12 articles). Each cluster was further subdivided: A) Interoperability and Integration (7 articles), B) Architecture Modeling (9 articles), C) Dynamic EA Planning (1 article), and D) Systemic Design (2 articles). We first present articles related to cluster 1. For sub-category D: [19] modifies TOGAF ADM to include a "Government Strategic Objectives phase", "Security Architecture," and "customized phase.". For sub-category A: [38] develops a structured approach, SGEA, for defining e-government EA scope. [30] proposes a National EA for implementing an e-government interoperability framework in Uganda. [37] explores how EA tools aid in regulation and legislation compliance. [20] examines EA tools in the public sector to achieve business ecosystem maturity. [47]

[2] using this SCOPUS query string: "(TITLE-ABS-KEY("Enterprise Architecture" AND "E-Government" AND "Interoperability") OR TITLE-ABS-KEY("decentralized Autonomous organisation" AND "Blockchain" AND "Governance") OR TITLE-ABS-KEY("Business Process Modelization" AND "Enterprise Architecture") OR TITLE-ABS-KEY("Enterprise Architecture" AND "Digital Ecosystem") OR TITLE-ABS-KEY("Requirements for Enterprise Architecture Frameworks") OR TITLE-ABS-KEY("Validation of Enterprise Architecture Frameworks quality") OR TITLE-ABS-KEY("decentralized Governance" AND "TOGAF" AND "ArchiMate") OR TITLE-ABS-KEY("Liquid Democracy" AND "Anarchist principles" AND "Blockchain") OR (TITLE-ABS-KEY("Enterprise Modeling") OR TITLE-ABS-KEY("Enterprise Architecture") AND TITLE-ABS-KEY("Blockchain" OR "decentralized Autonomous organisation" OR "DAO")))AND PUBYEAR > 2017"

discusses E-Government architecture in Indonesia using TOGAF and Service-Oriented Architecture. For sub-category B: [44] presents a Smart Campus System blueprint using TOGAF ADM, adapting TOGAF for specific domains and modeling socio-political artifacts. Next, we discuss cluster 2, starting with sub-category B: [26] explores BC's potential in enhancing business value creation, particularly in global supply chains, using ArchiMate models. [13] examines how EA approaches, especially ArchiMate, can design BC-based applications. [3] addresses the gap between enterprise engineering modeling methods and blockchain models. [15] proposes Knowledge BC for securely managing and tracking knowledge in organisations. [1] uses EA tools for developing digital twins for dry ports with ArchiMate. [14] discusses integrating BC into enterprise modeling and the mutual support between BC technology and modeling techniques. [29] focuses on structuring and implementing BC in enterprises, emphasizing the necessary layers for a robust BC platform. [33] develops a method for strategic analysis integrating business processes and IT infrastructure, focusing on GoalML, SAML, and ITML. For sub-categroy C: [11] discusses EA as a strategic tool for aligning business and IT, incorporating case-based reasoning and BC for knowledge storage and sharing. For sub-category A: [49] uses EA tools to address BC interoperability issues, while [40] proposes an architecture integrating BC into Health Information Exchanges (HIEs) to enhance healthcare data management and exchange. Finally, For sub-category D: [6] discusses the systematic design of BC-based applications, integrating business and IT perspectives. Analyzing this literature reveals a gap that our work aims to fill: EA for BC applied to socio-political artifacts/E-Government.

3 Research Methodology

To address our research problem, we employ the Design Science Research Methodology (DSRM) [24, 42], which consists of six steps: Problem Identification and Motivation, Objectives for the Solution, Design and Development, Demonstration, Evaluation, and Communication. We merge the Demonstration and Evaluation steps to better address our research questions. *Problem Identification and Motivation.* While DAO provides a set of mechanisms to implement decentralised governance and principles of liquid democracy, there is no evidence on how these organisations form can support other socio-political mechanisms, including principles and governance processes grounded on anarchism. We choose enterprise modeling and enterprise architecture disciplines to address the problem of alignment and traceability of socio-political artefacts in decentralised organisations. This motivates the following research questions: **RQ1**: How can TOGAF and ArchiMate be used to model socio-political artifacts within decentralised organisations? **RQ2**: How TOGAF and ArchiMate should be adapted to address socio-political artefacts in decentralised organisations? **RQ3**: In what ways can LD and DAOs can be used to achieve the organisation of anarchist societies? *Objectives for the Solution.* Establish key objectives: Design an architectural artifact using TOGAF ADM and ArchiMate to model DAOs with LD. Ensure

the artifact aligns with anarchist society principles. Validate the artifact's ability to support decentralised governance at scale. Here, we want to ensure that the artifact that we build is aligned with the anarchist society principles. We use the anarchist society principles that we elicit from the literature to design our artifact. *Design and Development.* Develop the artifact using TOGAF ADM and ArchiMate as architectural Framework, and employing modeling languages such as i* 2.0, BPMN and SysML/UML to design the motivation, business, application, and technology layers to assure that the artifact encapsulates the anarchist society principles. *Demonstration and Evaluation.* Demonstrate and evaluate the artifact by applying practical use cases based on anarchist society principles to verify alignment and conduct scenario analysis to demonstrate how to the artifact supports decentralised governance. We use an analytical evaluation as described by Hevner et al. [24] to evaluate the artifact and answer our research questions, more precisely the "Architecture Analysis". *Communication.* We have documented the research process, findings and some recommendations. Then we present the result in this paper.

4 Artifact Design

4.1 Design Principles, Rationale, and Development Approach:

In this work, we adopt the TOGAF ADM. It is an iterative process for developing architecture content, transition from the existing (As-Is) to the target (To-Be) architecture and the architecture governance [27].

We focus on the following ADM phases: Preliminary Phase, which describes the preparation and initiation activities required to create an Architecture capability and definition of Architectures Principles; Architecture Vision, which describes the initial phase of an architecture development cycle; Business Architecture, which describes the development of a Business Architecture to support an agreed Architecture Vision; Information Systems Architecture, which describes the development of IS Architectures to support the agreed Architecture Vision; and Technology Architecture, which describe the development of Technology Architectures to support the agreed Architecture Vision.

In the Preliminary Phase, we conduct a literature review of the anarchist literature. We derive the anarchist society principles from the various sources, including the research articles, books and essays. Our results are presented in the Table 1. We use these principles in the later phases, to guide the design our artifact.

4.2 Preliminary Phase:

In our study, we consider the organisation grounded on DAO and LD principles for the decision-making process. We model the organisation using Blockchain as the main technological babckbone. Within THIS such organisation, the team of

Table 1. Anarchist Society and Principles

Principles	[35]	[12]	[22]	[34]	[36]	[8]	[45]	[10]	[43]	[4]	[18]
Voluntary Association	✓		✓	✓			✓			✓	✓
Direct Democracy and Consensus Decision-Making		✓	✓		✓			✓	✓	✓	✓
Mutual Aid	✓	✓		✓		✓					✓
decentralisation						✓	✓	✓	✓		✓
Autonomy and Self-Management	✓					✓		✓			✓
Non-Hierarchical organisation		✓			✓		✓				✓
Commons and Communal Resources			✓	✓				✓	✓		✓

architects that implements TOGAF has to follow the principles of decentralisation and LD. Thus, the TOGAF implementation has to be adopted according to these principles.

We use Dapp and Smart Contracts to implement the LD principles and, in particular, the voting process. We choose NFT as a technological solution to determine the collective ownership of organisations, goods, services etc. We are using the TOGAF ADM from [27] and ArchiMate 3.2 to model our organisation.

4.3 Architecture Vision:

In the Architecture Vision phase we use the anarchist society principles from Table 1 to define the vision of the organisation. We present the principles of traditional centralized organisations/societies (As-Is), putting forward the main criticism advanced by the anarchist thinkers, and the principles of the target, decentralised organisations/societies(To-Be), in Table 2. This table illustrates how anarchist thinkers of their time viewed the state of centralized societies, especially the "collusion between capital and the state", which can be understood as "minority rule" as discussed in 2.2. The term should be contextualized within the specific conditions of that era.

Motivation Layer. In this layer, Table 2 is used to represent the current state of centralized organization with the ArchiMate Motivation "Assessment" concept. We apply the i* modeling language [51] to define actors, goals, tasks, and dependencies. From the literature, we identified three actors: Volunteer, Association, and Delegated. Figure 1 shows a fragment of the goal diagram illustrating a Volunteer's participation in an Association and their dependencies on Federation, LD, Blockchain infrastructure, and Smart contract agents[3]. In i*, an agent is "an actor with concrete, physical manifestations, such as a human individual, organization, or department" [7]. Goals derive from principles in Table 1. Several agents can share the same goal. Tasks associated with goal realization are based on anarchist literature analysis from the preliminary phase. Goals and tasks for Blockchain and Smart Contract agents are specified following [51]. Dependencies between agents' goals/tasks are also added, e.g., Federation and

[3] Full goal model available at: https://github.com/edoc2024/paper

Table 2. As-Is and To-Be Architecture Visions

As-Is traditional Centralized organisation/societies	To-Be decentralised organisations/societies
- Hierarchical and Centralized Power Structures	- decentralised Self-Governance
- Economic Inequality and Exploitation	- Collective, consensus and decentralised Decision-Making
- Competition over Cooperation	- Voluntary Association and Mutual Aid
- Lack of Autonomy	- Direct Action and Self-Management: This involves self-management practices where individuals and collectives take initiative and responsibility for managing tasks and projects
- "State and Capitalist Collusion" or Minority Rule	- Autonomy and Independence
- Resistance to Change and Innovation (the capitalist mode of production resists changes that threaten existing power structures or profit margins, even if such changes could benefit society as a whole)	- Restorative Justice
- Environmental Exploitation	- Equitable Resource Distribution -Continuous Learning and Adaptation

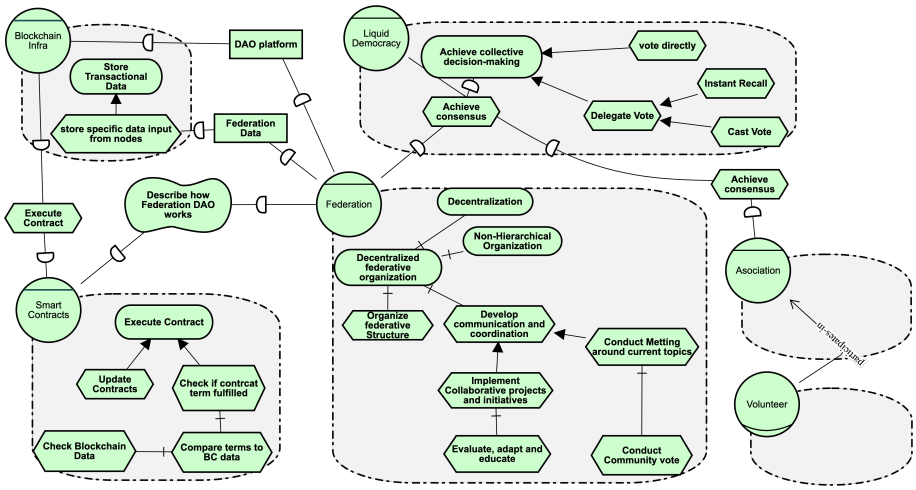

Fig. 1. Goal Diagram of the Architecture Vision

Association depend on Liquid Democracy for consensus, and Federation depends on Blockchain for enabling the DAO and data storage. Smart Contracts depend on Blockchain for execution. Using Figure 1 and principles from Table 2 and Table 1, we define the ArchiMate motivation layer[4]. ArchiMate Drivers link Assessments, Goals, Requirements, and Principles to stakeholders, isolating five drivers: 1) Community Need, 2) Social Expectation, 3) Organizational Culture, 4) Technology Advancements, and 5) Regulations. We use the literature analysis to further refines the motivation layer, including items not expressible in the i* diagram, such as the requirement for "Sustainable Practices."

4.4 Business Architecture

The Business Architecture phase defines the organisation's business processes. We use BPMN to model the business processes. The main business processes are: 1) The unified process for voluntary association, mutual aid and self-management, 2) The Decision-Making Process using LD, 3) The Equitable Resource Distribution Process. In this paper we present the process diagrams for Unified Process for Voluntary Association, Mutual Aid and Self-Management [5].

Unified Process for Voluntary Association, Mutual Aid and Self-Management
We define process activities and constraints using [4, 8, 10, 12, 18, 22, 34, 35, 45]. The Run Federation process diagram shows how members organize within federations, which are networks of autonomous groups based on mutual aid, voluntary association, and non-hierarchical organization (see [43]). Members establish goals, principles, structure, and coordination, operating by consensus and creating associations to meet needs. We describe how to run and manage associations following anarchist principles in the Collaborative and Initiatives Project Process and Conduct Association Operations. Associations are voluntary, cooperative groups pursuing common goals. We outline the global lifecycle of associations and the strategies for managing them. We define three main forms of association, each with its own processes: Run Community Engagement Project for addressing issues like education and healing; Run Awareness and Advocacy Project for promoting ideas; and Run Economic Project for providing goods and services. These processes facilitate organizing society without central authority, adhering to anarchist principles.

Business Architecture Layer
We integrate all the business processes (including those not present in this paper) into the Business Architecture Layer in ArchiMate[6]. The Unified Process for Voluntary Association, Mutual Aid, and Self-Management is the organisation's

[4] Complete motivation layer diagram available at: https://github.com/edoc2024/paper
[5] Extra BPMN diagrams: https://github.com/edoc2024/paper/tree/main/BPMN
[6] The complete business layer can be found here: https://github.com/edoc2024/paper

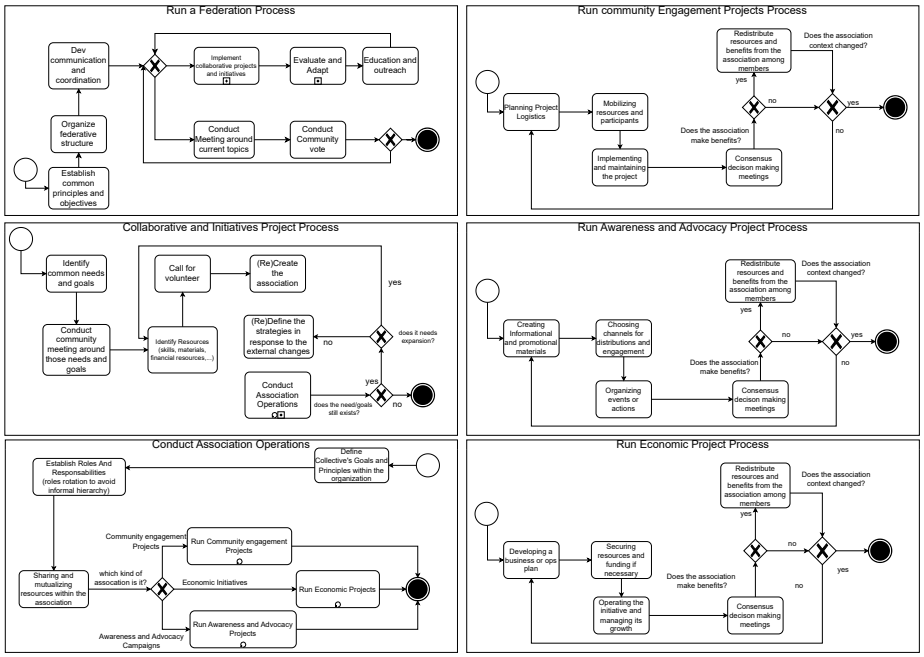

Fig. 2. BPMN of the Unified Process for Voluntary Association, Mutual Aid and Self-Management

core. It uses the LD process for decisions at both the federation and association levels. The Equitable Resource Distribution Process ensures fair resource distribution, from raw materials to dwellings, at both levels. For this paper, we present only a simplified version of the Unified Process for Voluntary Association, Mutual Aid, and Self-Management (see Figure 3). We can observe that the Run Federation Process achieves the decentralised Federation organisation Business Service. The Voluntary Association, Mutual Aid, and Self-Management Business Services are realized by the Collaborative and Initiatives Project Process, which embeds all of the other subprocesses described in Figure 2.

4.5 Application and Technology Architecture Layer

To design the Application and Technological Layer we use a detailed sysML Block Definition Diagram. As shown in Figure 4, we make some technology choices due to the need to study LD in DAO. To enable DAO, blockchain is used in the Technology Layer. The blockchain must support Turing-complete smart contracts. To construct this model, we use the goal diagram (see Figure 1). In white are actors identified during the anarchist and LD literature analysis. In blue are elements in the ArchiMate Application Layer, representing software components enabling business processes and motivation goals. Federation and

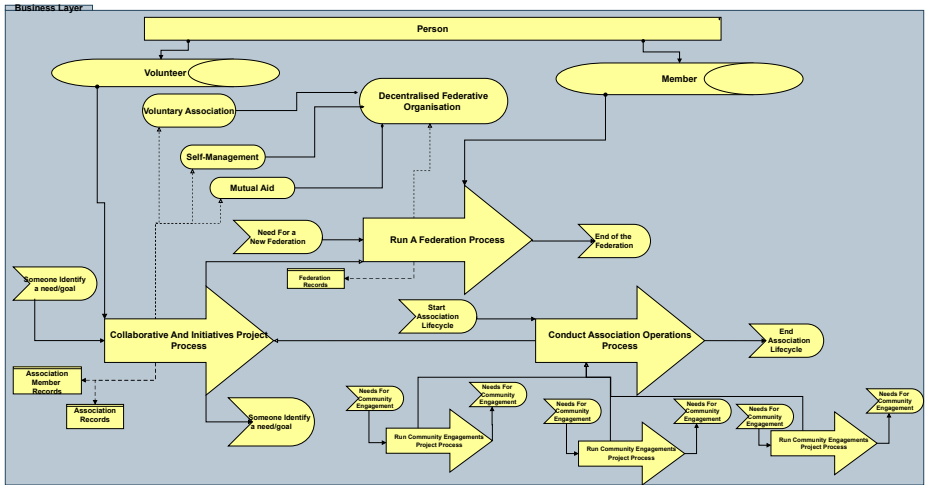

Fig. 3. Simplified ArchiMate Model of the unified process for voluntary association, mutual aid and self-Management

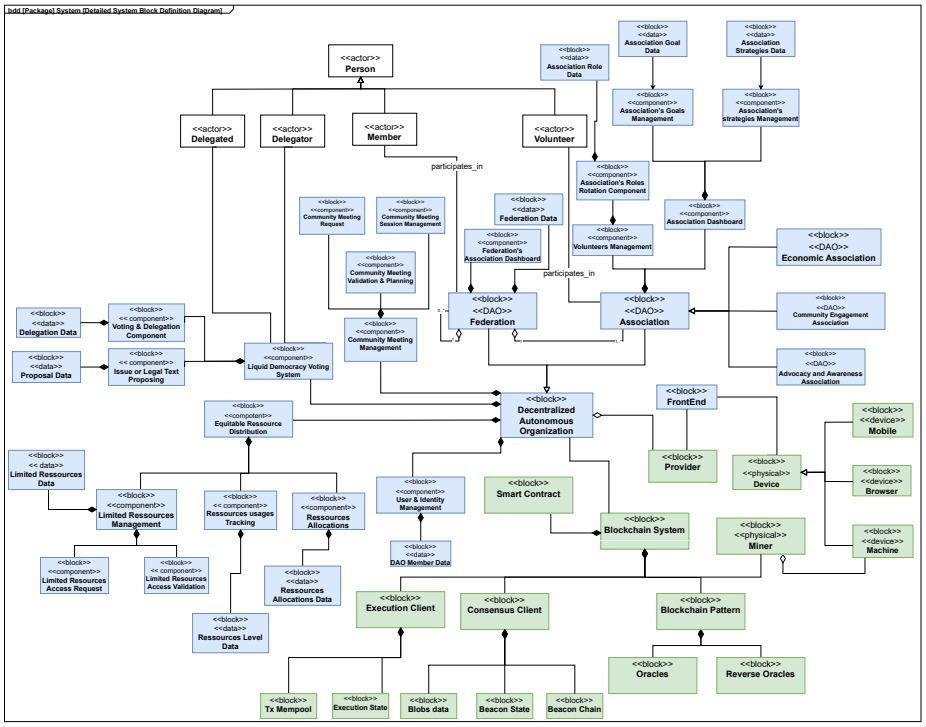

Fig. 4. Detailed Block Definition Diagram of the system

Association derive from the DAO block, built with the LD component, Community Meeting component, User & Identity Management component, and Equitable Resources Distribution component. These components support previously described business processes. In green are elements in the ArchiMate Technology Layer. We describe the Blockchain System to provide comprehension, including execution and consensus clients, and blockchain patterns like Oracle and Reverse Oracle for user interaction and smart contract triggering. We implemented a simplification of the BDD of the system in ArchiMate (see Figure 5).

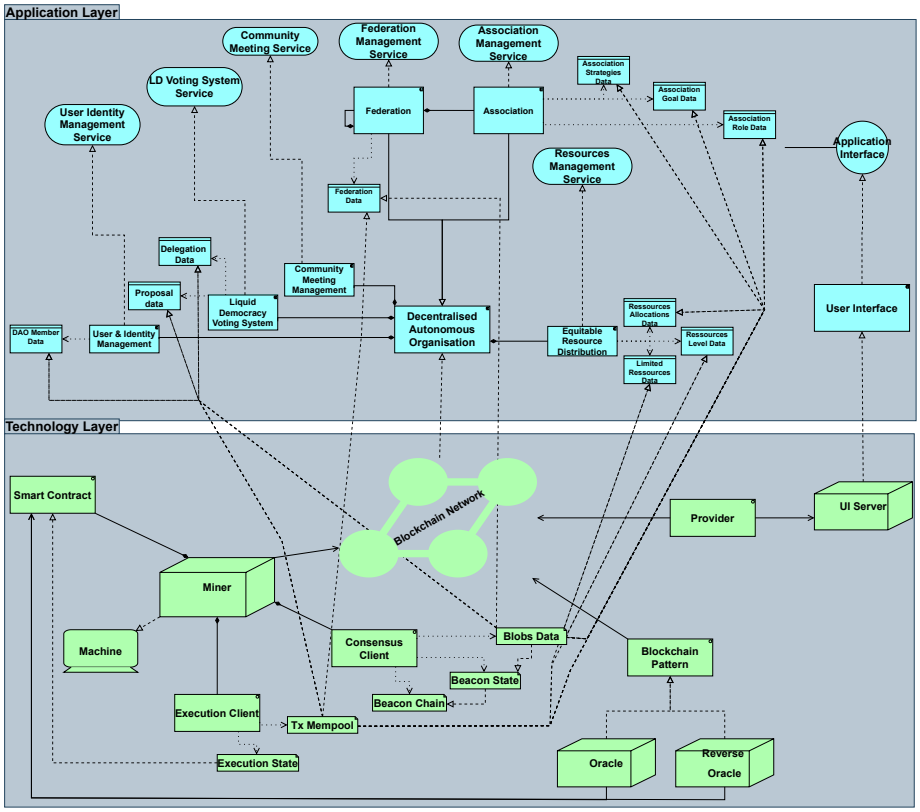

Fig. 5. Simplified ArchiMate Model of Application & Technology Layers

5 Evaluation

5.1 Evaluation Strategy:

Here, we are assessing how well the designed architectural artifact aligns with the anarchist society principles, goals and principles. Here is our evaluation ob-

jectives: 1) Validate the alignment(i.e: make sure that every elements from the motivation layer is linked to elements from the business, application and technology layer. And that the layer business is supported/realized by the application layer and that the application layer is supported/realized by the technology layer [28]) of the architectural artifact with anarchist society principles, 2) Asses the effectiveness of the artifact in supporting decentralised governance using DAOs and LD.

This evaluation is conducted using the ArchiMate enterprise model and according to the analytical methods described in [24]. Therefore we will follow these steps: 1) Map principles to architecture elements, we are using ArchiMate viewpoint to be able to highlight the alignment, then we ensure that each principles, goals and requirements are supported by the architectural artifact 2) Scenario based analysis, here we develop hypothetical scenarios to test how the architecture handles specific challenges To do so, we will use the motivation layer[7] that describes all of our requirements, principles goals.

5.2 Evaluation Criteria and Measures

Goals and principles Alignment and Traceability

Using the ArchiMate viewpoint of the requirements realization[8] , we can see that all of the business, application and Technology layers are used to support the motivation layer. We sum up these alignments in the Tables 3 and 4. To better understand them we recommend first to look at Figure 6.

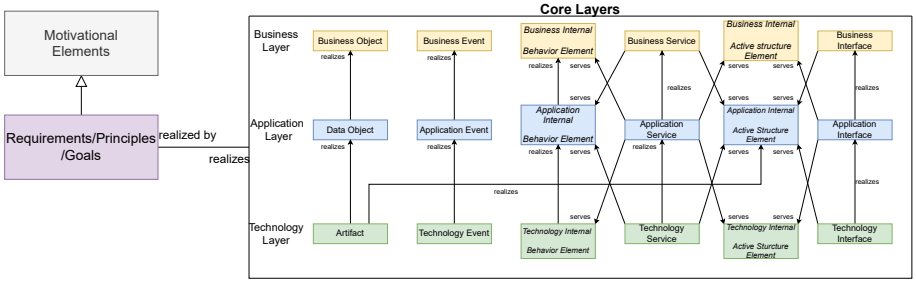

Fig. 6. ArchiMate & TOGAF layers alignment

In the Table 4, we merge "Transparent Governance" and "Conflict Resolution Mechanism" because they rely on the same Business, Application and Technological elements. Same thing for "Community Engagement" and "Collaborative Projects". Finally only the "Sustainable Practice" is not covered directly by the architectural artifact but this requirements apply to how individuals are behaving in the system and how they decide to respond to members' needs, so this

[7] The motivation layer can be dound here: https://github.com/edoc2024/paper
[8] The complete view can be found here: https://github.com/edoc2024/paper/

Table 3. Goals alignment and Traceability

Goals	Business Layer	Application Layer	Technology Layer
Non-Hierarchical organisation	"decentralised Federative organisation", "Mutual Aid", "Voluntary Association", "Self-Management" and "Run a Federation Process" and all the subprocesses	"Community Meeting Service", "Federation Management Service", "Resources Management Service", "Liquid Democracy Voting System" and all of the application supporting these services	"Blockchain Network" and all the elements supporting the network
decentralisation	"decentralised Federative organisation" and "Run a Federation Process" and all the subprocesses	"Community Meeting Service", "Federation Management Service", "Resources Management Service", "Liquid Democracy Voting System" and all of the application supporting these services	"Blockchain Network" and all the elements supporting the network
Equitable Resource Distribution	"Resource Sharing" business service and the "Equitable Resource Distribution Process"	"Resources Management Service" and all the application supporting this service	"Blockchain Network" and all the elements supporting the network
Mutual Aid	"Mutual Aid" business service and the "Collaborative and Initiaves Project Process" and all the subprocesses of this process	"Federation Management Service", "Association Management Service" and "Resources Management Service" and all the application components supporting these services	"Blockchain Network" and all the elements supporting the network
Autonmy & Self-Management	"Self-Management" business service and the "Collaborative and Initiatives Project Process" and all of the subprocesses of this process	"Association Management Service", "Community Meeting Service", "Liquid Democracy Voting system" and all of the applications supporting these services	"Blockchain Network" and all the elements supporting the network
Voluntary Association	"Voluntary Association" business service and the "Collaborative and Initiatives Project Process" and all of the subprocesses of this process	"Association Management Service" and all of the applications and services supporting it	"Blockchain Network" and all the elements supporting the network

Table 4. Motivation Layer Requirements alignment and Traceability

Requirements	Business Layer	Application Layer	Technology Layer
Transparent Governance and Conflict Resolution Mechanism	"Achieve Consensus"service and the "Consensus decision making through Liquid Democracy" process	"Liquid Democracy Voting System", "User Identity Management Service", "Community Meeting Service"	"Blockchain Network" and all the elements supporting the network
Community Engagement and Collaborative Projects	"Collaborative and Initiatives Project Process"	"Community Meeting Service", "Federation Management Service", "Resources Management Service", "Liquid Democracy Voting System" and all of the application supporting these services	"Blockchain Network" and all the elements supporting the network
Equal Access to Resources	"Resource Sharing" business service and the "Equitable Resource Distribution Process"	"Resources Management Service" and all the application supporting this service	"Blockchain Network" and all the elements supporting the network

principle will be used when association are created to ensure sustainable practices. Finally the Principle "decentralised organisation" is applied to all of the system as well as "Liquid Democracy" principle.

Scenario based analysis

We examine five scenarios involving our architectural artifact: 1) Federation Management of Member Needs, 2) Deciding the Direction for an Association, 3) Resource Sharing Among a Federation, 4) Conflict Resolution Between Associations, and 5) Emergency Response and Resource Reallocation. 1) In the first scenario, a member submits a need request. The federation analyzes it, drafts a proposal, and uses the Liquid Democracy process for consensus. If approved, a new association is formed to address the need, with roles assigned. Outcomes

include effective need fulfillment and a transparent, inclusive process following anarchist principles. This scenario involve the following principles: "voluntary association" [4, 18, 22, 34, 35, 45] and "direct democracy and consensus decision-making" [4,10,12,18,22,36,43]. 2) In the second scenario, if an association needs a change in direction, feedback is gathered. The LD system aids in building consensus, refining goals, and developing an action plan. Roles and responsibilities are assigned, and progress is monitored and adjusted as needed. Outcomes are clear strategic direction and adherence to anarchist principles. This scenario involve the following principles: "direct democracy and consensus decision-making" [4, 10,12,18,22,36,43] and "autonomy and self-management" [8,10,18,35]. 3) In the third scenario, resource requests are evaluated within the federation. Resources are categorized, and limited resources are allocated based on priority. Outcomes are effective resource use and fulfillment of members' needs. This scenario involve the following principles: "commons and communal resources" [10, 18, 22, 34, 43] and "Mutual Aid" [8,12,18,34,35]. 4) In the fourth scenario, conflict reports are discussed in a federation meeting. A resolution proposal is submitted to the LD process. If approved, the resolution is implemented, and the outcome is reviewed in the next meeting. Outcomes include fair conflict resolution and process transparency. This scenario involve the following principles: "direct democracy and consensus decision-making" [4,10,12,18,22,36,43] and "Non-Hierarchical Organisation" [12, 18, 36, 45]. 5) In the fifth scenario, an emergency prompts a rapid assessment and reallocation of resources. The LD system prioritizes emergency needs, reallocating resources from non-essential projects. Outcomes are efficient emergency response and improved system resilience. This scenario involve the following principles: "decentralisation" [8,10,18,43,45] and "autonomy and self-management" [8, 10, 18, 35]. These scenarios demonstrate that our architectural artifact supports anarchist society principles, effectively handling challenges in a decentralised organisation.

5.3 Discussion

The key findings are as follows: **RQ1**: TOGAF ADM and ArchiMate effectively model socio-political artifacts for decentralized organizations. By structuring the model with the Motivation Layer (covering goals, requirements, and principles) and supporting it with the Business, Application, and Technology layers, we could visualize and manage alignment with anarchist society principles. The final steps of TOGAF ADM (*Opportunities and Solutions*, *Migration Planning*, *Implementation Governance*, and *Architecture Change Management*) were not implemented as they are meant for bringing the architecture into the real world, while our focus was on constructing the architecture and verifying its alignment. However, these steps can be carried out using this reference architecture. **RQ2**: We found minor areas for improvement in ArchiMate, but not in TOGAF ADM. For example, translating the Technology layer from Figure 4 into ArchiMate required compromises like making the miner central in the technology layer rather than the blockchain system. These issues are mainly syntactic, not

semiotic. Overall, modeling decentralized organizations is feasible with ArchiMate and TOGAF ADM in their current forms. **RQ3**: Our evaluation shows that the architectural artifact aligns with anarchist society principles, indicating that DAOs using LD can support an anarchist society (see Section 5.2). We also developed a model for LD decision-making, but due to space constraints, it is not included here[9]. Anarchist literature underpinned the artifact's development, with elements in the Motivation Layer (Section 4.3) representing principles and goals from the literature. Business processes enable the creation of federations and associations using LD-based decision-making and equitable resource sharing, operationalizing preferences while adhering to anarchist principles (see Section 4.4). These processes are supported by DAOs and decentralized applications, powered by blockchain and smart contracts, as detailed in Section 4.5.

6 Conclusion and Future work

This paper provides a foundational model for integrating DAOs and LD with anarchist society principles, but further exploration is needed. **Empirical Validation**: Our theoretical model needs real-world validation. We plan to implement and observe the system and individual behaviors in this new socio-political context. The goal will be one to document the instantiation of such an artefact and then conduct an Ethnography on the organization to be able to empirically validate the anarchist principles and this artefact already theoretically validated. **Enhanced Modeling Techniques**: We identified new modeling languages and techniques, such as the DECENT framework by [31], to enhance our model. **Blockchain Patterns**: We identified blockchain patterns to enhance the technology layer such as the "Oracle" or "Reverse Oracle" to let the real world interact with the blockchain and enables Smart Contracts. During the implementation of our artefact we might faced issues (e.g: Token management to determine collective ownership). Therefore We will conduct a systematic literature review to identify all relevant patterns to cover all of our use cases. This work could not be included in this paper.

In this research, we investigate *How can socio-political artifacts for decentralised organisations be addressed by Enterprise Modeling?*, focusing on how DAOs and LD can model anarchist societies. We designed an architectural artifact using TOGAF ADM and ArchiMate for this purpose. Our main contribution is the reference architecture presented in this paper and where a more detailed version is available here https://github.com/edoc2024/paper.

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[9] These models can be found at: https://github.com/edoc2024/paper

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