A Computational Decision Support Workflow for Requirement Engineering in DAOs

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***Abstract*—Decentralized Autonomous Organizations (DAOs) are reshaping digital infrastructure by distributing authority and responsibility across diverse, often loosely connected participants. This decentralization introduces unique challenges for requirements engineering, particularly in achieving effective communication, maintaining traceability, and supporting robust decision-making. This paper argues that Computational Decision Support Systems (CDSS) can address these challenges, and we propose a novel workflow that leverages CDSS to structure governance in DAOs into explicit, iterative phases. Our approach enables DAOs to formalize requirements, document decisions, and adapt as their communities evolve over time.**

***Index Terms*—decentralized applications, requirements engineering, decision support systems**

I. Introduction

The governance of digital infrastructure is being fundamentally reshaped by the rise of Web3 and Decentralized Autonomous Organizations (DAOs). Unlike traditional organizations, DAOs distribute authority and responsibility across diverse, often loosely connected participants, creating new challenges for developing and sustaining critical online systems. In this context, requirements engineering (RE) – the discipline of communicating, aligning, and documenting operational constraints to meet strategic stakeholder goals [1] – becomes essential. Effective RE enables DAOs to coordinate collaboratively, satisfy shared constraints, and ensure that decisions remain transparent and traceable as communities grow and evolve. Although many different requirements engineering frameworks exist, they share foundational elements: unambiguous language, clear documentation, and temporal tracking of decisions and changes [2].

Traditional requirements engineering relies on hierarchical structures, clear roles, and established processes to translate strategic goals into actionable requirements. In early-stage Web3 projects, similar practices are often adopted by small founding teams. However, as DAOs mature and governance and development responsibilities are distributed among a global, often disconnected, community, these approaches break down. Authority may remain with early stakeholders, alignment on goals becomes complex and costly, and the volume of decisions can lead to fatigue and information overload. This distribution introduces additional challenges such as increased information loss, fragmented processes, and communication overhead. While existing RE frameworks emphasize unambiguous language, clear documentation, and traceability, maintaining these standards becomes increasingly difficult as stakeholder participation grows and becomes more heterogeneous.

In this paper, we propose a *computational decision support workflow tailored for requirements engineering in DAOs*. Our approach leverages Computational Decision Support Systems (CDSS) to address the unique challenges of decentralized governance. Unlike traditional RE processes, our workflow is designed to maintain alignment, minimize information loss, and support effective decision-making among diverse and distributed participants. Our workflow *structures governance into explicit, iterative phases with proposal and voting stages*, enabling DAOs to formalize requirements and adapt decisions as their communities evolve.

To demonstrate the effectiveness of our approach, we analyze how the proposed workflow addresses three core challenges: communication around requirements, traceability of decisions, and decision-making under uncertainty. Drawing on literature from both requirements engineering and decentralized governance, we show that our workflow clarifies requirements, strengthens decision traceability, and helps DAOs manage uncertainty and stakeholder alignment as they scale.

This paper makes the following key contributions.

- A structured, iterative workflow for requirements engineering in DAOs, integrating computational decision support at each stage.
- A framework for enhancing communication, traceability, and decision-making under uncertainty in decentralized governance.
- An analysis of how the workflow addresses core RE challenges unique to DAOs.

The remainder of this paper is structured as follows. Section II contextualizes the discussion and introduces the concept of Computational Decision Support. Section III describes three prevalent challenges in requirements engineering that emerge in decentralized governance. In Section IV, we propose a CDSS workflow to help DAOs systematically reason about conducting computational governance. In Section V, we demonstrate an example application of the proposed workflow using a hypothetical DAO decision problem. Section VI discusses how CDSS can mitigate the identified challenges. Section VII discusses the limitations of the proposed workflow, and identifies avenues for future research. Section VIII concludes.

II. Preliminaries

As Decentralized Autonomous Organizations (DAOs) scale, the complexity of coordinating and aligning decisions between diverse participants increases [3]. Localized design choices can have systemic implications, where decisions made by one team inadvertently introduce constraints or requirements for others [4]. DAOs often face increasingly complex and interdependent concerns that span their modules and organizational boundaries. This increases the misalignment of constituent working groups around the broader organizational goal(s).

Although DAOs often reduce governance to the act of voting, effective governance encompasses much more than simply casting votes [5]. Voting is only one component within a broader set of processes that include, among others: deliberation, information sharing, context building, articulation of assumptions and rationales, efficient assignment and reevaluation of decision-making authority, and establishing the legitimacy of any decisions made [6], [7]. For participants to make informed and meaningful decisions, they must, therefore, have access to concrete, verifiable information, legitimate mediums of communication, and a clear understanding of the context and underlying assumptions that shape each decision [8].

Computational Decision Support Systems (CDSS) can provide governance participants with the requisite information and understanding needed to make informed decisions. CDSS are models of a system that help decision-makers evaluate complex scenarios and their potential outcomes [9]. Such information systems are beneficial for making decisions about problems that are either rapidly evolving or are difficult to specify in advance [9]. In the context of decentralized governance, CDSS are models that capture stakeholder preferences and system dynamics, enabling governance participants to evaluate the potential consequences of their policy decisions before implementation [10]. The purpose of CDSS is to provide analytical support that enables more informed deliberation and consensus building.

The application of computational approaches to decentralized governance has gained significant traction in recent years. Computer-Aided Governance is a framework for using simulations to test and validate the design and implementation of policies [10]. It encompasses a broader process map that explores the use of computers to better reason about and steer complex systems [11]. Within this framework, our proposed CDSS workflow is a complementary high-level process to help DAOs systematically reason about conducting computational governance. In line with this, CDSS focuses specifically on the workflow required to build governance consensus around the modeling components, including objective functions, simulation parameters, and evaluation criteria.

Governance participants can use CDSS to understand and reason about the systemic implications of localized design decisions [12]. CDSS offers a rigorous, public, and persistent medium for formally capturing stakeholder preferences. With CDSS, the goal is not to overwhelm participants with too much information or to involve everyone in every decision. Instead, it is to share clear and relevant information with the right people, such that those with the necessary knowledge or decision-making authority are empowered to make better decisions. CDSS helps reduce ambiguity, provide explicit context, and empower participants to evaluate the consequences of their choices against shared metrics derived from community values, thereby reducing the loss of transmission in communication. This approach ensures the decentralized governance of development is efficient, legible, and legitimate for the community.

The translation of strategic goals into operational decisions remains inherently lossy [13]—a problem exacerbated by the move away from traditional hierarchical organizations toward flatter, less formally structured systems characterized by informal online discussions, ad hoc voting mechanisms, and ambiguous distributions of authority. As highlighted in [12], without formal models, communication pathways risk insufficiently transmitting goals or rationales, leading to decisions that are misaligned or incoherent at the system level.

CDSS can help mitigate these risks. Mental and conceptual models will inevitably continue to guide communication, but without formal articulation, much of the accompanying nuance and structure is lost. By making reasoning explicit and traceable, CDSS helps bridge the gap between strategic goals and operational decisions, even as authority and responsibility become more diffuse. Moreover, CDSS supports the evolution of requirements as living constructs, maintaining institutional memory, and enabling version control as governance structures and system designs change. This is particularly critical in DAOs, where turnover is high, and the set of stakeholders is constantly evolving. Without explicit models, much of the tacit knowledge and rationale behind past decisions is lost, increasing the risk of incoherent or conflicting outcomes.

To address the loss of decision-relevant information, DAOs require both explicit modeling tools, and structured governance processes that embed modeling into their workflows. CadCAD [14] is an open-source framework developed by BlockScience for modeling complex systems. It enables formal reasoning about systems through simulation, aiding for example deliberation on policy choices in DAO governance. While cadCAD can serve as a technical foundation for a CDSS, it does not inherently prescribe how DAOs should coordinate around its use. Its current use in DAOs is typically performed by external parties as a consulting service (e.g. in [15] it was used to better understand the automated price stability mechanism of OlympusDAO). Our contribution builds explicitly on this gap: we do not propose a new simulation engine, but rather a decision support workflow, with the aim of enabling DAOs to use CDSS on their own. This includes a governance-compatible sequence of phases for defining policy variables, agreeing on an objective function, and iterating over simulation assumptions. By framing tools like cadCAD as the backend computational engine within the broader socio-technical process of governance, we clarify how DAOs can transform simulations into collectively understood governance artifacts.

III. Challenges

As DAOs grow, several RE-relevant challenges emerge. These challenges stem from scaling communication, preserving the rationale behind decisions over time, and mitigating the information overload experienced by participants. In this section, we discuss three core challenges: (1) communicating around requirements, (2) ensuring decision traceability, and (3) addressing uncertainty in decision-making. Where possible, we connect these challenges to those identified in existing RE literature, highlighting how traditional issues are exacerbated in large-scale distributed governance settings.

A. Communicating around Requirements

Communication around requirements is often difficult. Moving from high-level requirements to concrete KPIs is a complex and often lossy process. A typical example of this issue is the widely desired property of ”decentralization,” which in practice is interpreted differently from stakeholder to stakeholder [16]. It is not always clear how to translate vague stakeholder goals into measurable metrics or how to ensure that these metrics truly reflect what is essential for the system. Even if stakeholders reach a common understanding of how to interpret a particular KPI, they are likely to prioritize it differently [17]. These differences can lead to misalignments that hinder development before it has even begun.

The technical complexity of the environment in which decentralized governance operates introduces an additional layer of communication difficulty when coordinating around KPIs. Requirements must often account for underlying protocol-level constraints and economic incentives, whose constituent concepts may not be familiar to all stakeholders participating in governance. This creates an expertise asymmetry, where technical stakeholders find themselves with disproportionate influence over the definition of requirements [18]. Diversity of input—from domain experts, end users, or other non-technical community members—can contribute to more precise requirements that better align with the governed system's goals. However, diversity in the governance set comes at the expense of decision-making speed [5].

Having a diverse governance set does not suggest better communication around requirements. As highlighted in [5], it is necessary to ”[incorporate] these varied perspectives in decision-making.” Therefore, achieving consensus on what should be measured and how to interpret those measurements is evidently a core challenge of RE in DAOs. Looking forward, there is a clear need for frameworks that not only capture requirements and KPIs but also enable explicit discussion on associated metrics. This would help stakeholders understand where their perspectives align or diverge, supporting more robust and transparent decision-making as systems and communities grow in complexity.

B. Requirements traceability

A key challenge closely linked to communication is decision traceability. As highlighted in [4], maintaining traceability is particularly challenging in complex systems with distributed and changing stakeholders. In practice, many common governance decisions (such as parameter updates or protocol changes) are made as localized optimizations, reflecting the knowledge and priorities of the moment. However, these decisions can lack a clear connection to the broader context or the original reasoning behind them [19]. As governance structures evolve and participants come and go, the loss of this context makes it difficult for future stakeholders to understand, evaluate, or revisit past choices.

Requirements traceability is a well-established principle in engineering, ensuring that every decision can be linked back to explicit requirements and the rationale for those requirements [1]. In the context of distributed systems, this principle must extend beyond the engineering of the infrastructure itself to include the engineering of governance processes. Both the system and its governance mechanisms require transparent, traceable records of why decisions were made, what requirements they were intended to satisfy, and what assumptions underpinned them.

To support communities that grow or shrink over time, it is essential to provide traceable records. This traceability is currently lacking; governance decisions are often disbursed over various forums and improvement proposals with no explicit linkage. In contrast, artifacts such as decision logs, requirement documents, and contextual discussions that are temporally sustained and easily referenced better suit the demands of decentralized governance. Such artifacts allow new or returning stakeholders to dispute, contextualize, or build upon previous decisions, even if they were not present when those decisions were made [19]. This is particularly important in decentralized governance, where stakeholder turnover is high and institutional memory is fragile.

The stability expected of critical infrastructure maintained by decentralized governance further underscores the need for frameworks that provide robust traceability. Stable systems require careful, safe iterations, and the ability to review and understand the reasoning behind past changes is crucial for making informed, low-risk adjustments in the future.

C. Decision-making under uncertainty

While clear communication and traceability are essential for effective governance, a further challenge remains: how do we make sound decisions when information is incomplete, stakeholder interests are diverse, and the consequences of actions are uncertain? Traditional RE frameworks acknowledge uncertainty as a fundamental challenge, particularly given that requirements are expected to evolve iteratively [1]. RE in the context of decentralized governance is no different. The interconnected nature of protocol decisions means that changes to one parameter can have cascading effects that are difficult to predict. Additionally, the immutable nature of many on-chain decisions creates high stakes for decision-making, especially in an adversarial environment. Because decisions must be coordinated across a far greater number of participants, decentralized governance often has extended deliberation periods during which exogenous conditions relevant to the decision may change, potentially invalidating earlier assumptions.

These dynamics create uncertainty that is distinct from traditional contexts. Uncertainty in traditional software development can be managed through rapid prototyping and iterative feedback loops with a stable set of stakeholders [20]. In contrast, DAOs have unclear implications for economic and technical decisions, and the criteria by which the success of those decisions should be measured evolve as new stakeholders join the governance process or exogenous shocks to the protocol occur. The uncertainty faced in decentralized governance highlights the need for frameworks that facilitate ex-ante analysis of decisions against explicit criteria. Such frameworks would enable communities to systematically evaluate trade-offs and potential consequences before committing to irreversible choices.

IV. Proposed Workflow

We propose a decision support workflow designed to mitigate the RE challenges in DAOs highlighted above. CDSS are recognized as a useful tool to guide decision-making under uncertainty [10]. Creating a CDSS in the context of a DAO requires addressing the communication and tracebility requirements outlined in the previous section. In this section, we propose a workflow for creating a CDSS that addresses the requirements of communication and traceability challenges specific to the context of a DAO.

To address the requirement of decision traceability, we introduce distinct phases, each comprising a proposal and a voting stage. In the proposal stage, parties can submit their proposals on-chain, and in the voting stage, one proposal is chosen. Each phase addresses a distinct aspect of the CDSS. By focusing on specific aspects at a time, we aim to enhance transparency in decision-making and streamline discussions. By enforcing sequential decision-making, we aim to establish a (soft) commitment to previously agreed-upon aspects of the CDSS design. We propose both an internal and external loop to allow revisiting previous design decisions, in line with the general iterative nature of RE. The importance of iteration trumps that of commitment, but by explicitly revisiting an earlier decision, our framework fulfills the requirement of traceability for the CDSS design process. The communication requirements are addressed in its own phase, as will be seen below.

The public and irreversible nature of on-chain governance supports our aims. Irreversibility does not mean that decisions cannot be revised - our proposed workflow includes loops, after all - but creates transparency when it is done. The five phases of our proposed workflow are:

a) Define the policy variables: policy variables are those parameters over which the underlying decision should be taken. Defining those variables is the first step in the workflow, as the need for a policy decision typically triggers the decision-making process. In the context of Web3 applications, a proposal for policy variables could include a token distribution rate, a collateralization requirement, or, more broadly, a set of new features.

b) Define the objective function: The objective function should capture the goals and priorities of the community in a quantifiable form. It is in this phase that communication about KPIs and their relative importance occurs. By making a proposal with a specific objective function, one needs not only to explain which KPIs should be used but also how they should be weighted so that they can be combined into a scalar metric. The KPIs themselves should be variables that a simulation model can capture. Potential examples typical of Web3 applications could include projected daily users, transaction volumes, price volatility, or other metrics.

c) Define a simulation model: At its core, the simulation model needs to map policy variables to the parameters of the objective function. A typical example could take the form of a dynamical model $x_{t+1} = f_\theta(x_t, t)$, where x is a vector of state variables, t is a time index, f is a vector-valued function that describes the update of state variables for a discrete time step and θ are parameters of the model. Such parameters could represent policy variables, assumptions or other inputs. We present a generic form of such a model, as the workflow itself is not meant to be limited to any particular functional or other type of model. Creating a simulation model is generally the crux of a CDSS. It may become apparent in this phase that the objective function may have been poorly defined, with KPIs that are difficult to model. For this reason, we propose including an inner loop by making it an option to return to the objective function phase at the voting stage.

d) Set up scenarios: A scenario is a set of starting values for the state variables of a simulation model and specific values for all policy variables and other parameters of the model, including a time horizon for how long the simulation should be run. It is possible to propose more than one scenario, as the purpose of our workflow is not to lead to an automated decision based on a single run of the model but to provide quantitative input for a decision that is again based on a voting procedure. It can, therefore, make sense to evaluate more than one scenario to provide a better basis for decision-making. A scenario can define specific values for the policy variables or leave the optimization of those variables to the next phase.

e) Simulate model: run the simulation model for each scenario over the defined simulation horizon. Suppose specific values for the policy variables are defined as part of the scenario. In that case, a simulation run might resemble a single-shot run of a deterministic model or a Monte Carlo simulation of a stochastic model. Suppose the scenario does not define policy variables. In that case, the task in this phase consists of finding optimal values for these variables, and the choice of an optimizer becomes part of the proposal for this stage.

Figure 1 provides a graphic illustration of our proposed workflow, showing the proposal and voting stages for each

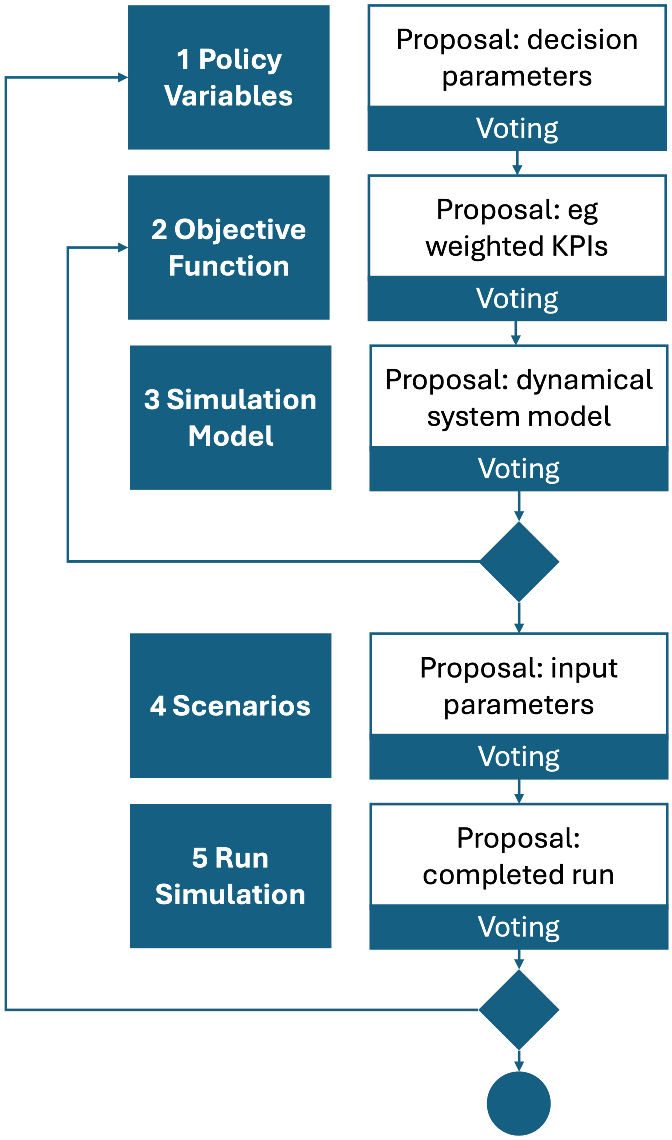

Fig. 1. Proposed workflow

phase, as well as the inner loop that allows for iterating over the objective function after the voting in the modeling phase and the outer loop for iterating over the entire CDSS design, keeping in mind the iterative nature of RE.

V. Example Application

As an example for a decision-making problem we consider the scenario of a hypothetical DAO that manages a decentralized stablecoin based on a lending protocol for a single asset. The basic functionality of such a protocol is that users can deposit the underlying asset into a vault. From this vault they can borrow units of the stablecoin up to a certain percentage of the current monetary value of the deposit, for which they pay a lending rate. Their deposited asset serves as collateral for the loan. The lending rate as well as the collateralization rate are both protocol parameters. The collateralization rate affects both the adoption of the protocol as well as its economic stability: a lower capitalization rate allows people to borrow more, potentially increasing adoption, but at the same time reduces the available risk buffer to avoid undercapitalization of the stablecoin under large swings in the market price of the underlying asset. We now consider the example decision making problem of changing the collateralization rate, using the workflow outlined in Section IV:

a) Define the policy variables: in this example there is one policy variable, the required collateralization rate. We consider a simple situation where a single new value for the collateralization rate is considered against the current value.

b) Define the objective function: relevant KPIs for a lending protocol could include protocol revenue, number of users (active vaults), total value locked, probability of a bank run, and others. An objective function could compare each KPI in the scenario against its current level and assign a signed weight. Among the example KPIs, the probability of a bank run would likely have a negative weight, while all other weights would typically be positive.

c) Define a simulation model: a simulation model would have to connect the collateralization rate to all the KPIs in the objective function. Creating such a link would require modeling how the collateralization rate affects user adoption, both by depositors and borrowers. This would allow computing protocol revenue using the lending rate. The probability of a bank run would have to consider the volatility of the underlying asset and simulate the probability of the protocol becoming undercapitalized, using, e.g., a random walk model for the asset price and assumptions about the speed of liquidations.

d) Set up scenarios: important parameters affecting the outcome of the simulation include the lending rate, as well as potentially market interest rates such as comparable rates by competing protocols and treasury bond rates. These could be kept at their current levels in the simulation, but a more informative approach would be to consider different combinations of values for both rates. The scenario horizon could cover, e.g., 1-5 years.

e) Simulate model: Most parts of the described model could probably be directly computed deterministically, the simulation of bank runs, however, might require a Monte Carlo simulation.

The resulting output after the workflow has terminated, after potentially several iterations, would be a set of simulation results under different interest rate environments for KPIs including protocol revenue and the probability of a bank run. A comparison of the simulation output for the current collateralization rate against the new proposal could then form the basis for a DAO decision on whether the new proposal should be accepted.

VI. Discussion

The proposed CDSS workflow addresses the three core RE challenges identified in Section III by structuring the governance process in a transparent and traceable way. In this section, we examine how each challenge is mitigated and discuss the broader implications for decentralized governance.

a) Addressing Communication Difficulties: Our proposed framework requires that governance stakeholders define KPIs and their associated metrics before proceeding to parametrization. This explicitness prevents the ambiguity that otherwise surrounds strategic objectives. In addition, a clear distinction between decision and environmental parameters helps limit confusion regarding the scope of changes being governed. Furthermore, structuring the workflow to progress from vague goals to an objective function agreed upon by consensus ensures stakeholder priorities are made explicit and weighted accordingly rather than remaining implicit. Bringing transparency to this aspect of the governance process helps participants identify where their perspectives genuinely diverge versus where apparent disagreements stem from miscommunication or unstated assumptions.

b) Improving Traceability of Requirements: it is expected that throughout the workflow, artifacts relevant to the governance of a decision are committed on-chain. This prevents post-hoc manipulation of requirements, where KPIs or parameters are retroactively adjusted to favor particular stakeholders. The immutability of the chosen data availability layer ensures that institutional memory persists in the long term. Further, outputs from the CDSS capture the forecasted outcomes of specific parameterizations, thereby providing accountability for governance decisions. When observed outcomes diverge significantly from predictions, governance stakeholders can trace back through the workflow to identify limitations in the underlying assumptions. Such retrospection can help to improve both the governance process itself and the system being governed.

c) Managing Uncertainty: By delineating environmental and decision parameters, the proposed workflow turns uncertain decisions into structured risk assessments. Instead of relying on informal deliberation, the workflow uses optimization of the objective function as the principled method for navigating trade-offs between competing KPIs. Furthermore, by simulating many environmental parameterizations, governance participants can better understand the robustness of their proposed changes in the event of exogenous shocks. Although uncertainty cannot be eliminated, the iterative nature of the workflow means new information can be incorporated into the CDSS as it becomes available.

d) Implications: This workflow connects the rich informality of community-driven governance with the rigor of quantitative analysis. By embedding CDSS directly into governance processes, natural checkpoints emerge that encourage more informed deliberation among governance participants while bringing improved transparency, accountability, and traceability to the RE process. Furthermore, a structured workflow, such as the one proposed, enhances the flexibility of delegation within the DAO. Once the community reaches a consensus on KPIs, they can vote to delegate the modeling and analysis phases to specialized working groups, which ultimately provide concrete recommendations back to the community. In this way, the workflow can help limit the information overload faced by governance participants while ensuring inclusive participation in strategic decisions. In addition, by requiring agreement on evaluation criteria, the risk of arbitrary and/or inconsistent decision-making, which can undermine both system stability and stakeholder confidence, is reduced. Clear quantitative standards ensure that decisions are ultimately taken based on their alignment with community-defined values rather than the economic or political influence of particular stakeholder groups.

VII. Limitations and Future Work

We have proposed a workflow to address RE challenges that we identified. A key limitation for future work is to test our proposed workflow in a real-world project, thereby collecting empirical data points that could inform future refinements of the model. Potential areas for investigation or improvement may include tackling participation. Namely, the proposed workflow requires multiple voting phases spread out over time, which may pose a challenge for user engagement and retention. This could be mitigated by incentivizing participation through token rewards for accepted proposals. These rewards would need to be calibrated carefully so as to not reward unhelpful submissions, for example by creating a committee for reward decisions. Another area for improvement might be the required effort. Creating a simulation model is substantial effort and may only prove viable for critical, strategic decisions. Token rewards could help address this problem as well. Another potential mitigation strategy could involve model reuse (which is compatible with the proposed workflow). Furthermore, the required effort could be reduced by extending the workflow with templates for proposals, models and best practices.

One commonly observed mitigation of effort and participatory barriers in DAOs is delegation. By delegating governance power, users can absolve themselves of the effort needed to participate in the proposed workflow. This constrains the users' governance decision to an ongoing choice as to which delegate best represents their interests. However, as identified in Section III-A, this mitigation approach would reintroduce expertise asymmetry, further driving up barriers to participation. Incentivizing users to expend the requisite effort to participate, or removing their need to do so through delegation, are two opposing strategies that serve to improve the efficiency of the governance process. However, driving community engagement in DAO governance is a long-standing research problem.

VIII. Conclusion

We identify three main challenges for RE in the context of DAOs, where decisions are made more difficult by diffuse responsibilities and informal hierarchies. These comprise communication challenges around requirements, such as the selection and prioritization of KPIs; the traceability of decisions, as records are often scattered across different media with unclear retention policies; and decision-making under uncertainty, a traditional RE challenge that is compounded in a decentralized context. To address these challenges, we propose a workflow for leveraging CDSS for decision-making in DAOs. Our proposed workflow consists of five phases, focused on different aspects of the CDSS in a sequential order. Each phase consists of a proposal and a voting stage, with an inner and outer loop to allow for iteration. This workflow is designed to address the communication, traceability, and decision-making challenges specific to DAOs that we identified.

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