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Research Article

A decision model for decentralized autonomous organization platform selection: Three industry case studies

E. Baninemeh [a,*], S. Farshidi [a], S. Jansen [a,b]

[a] Department of Information and Computer Science, Utrecht University, Utrecht, the Netherlands
[b] Department of Software Engineering, Lappeenranta University of Technology, Lappeenranta, Finland

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ABSTRACT

Context: Decentralized autonomous organizations are a new form of smart contract-based governance. Decentralized autonomous organization platforms, which support the creation of such organizations, are becoming increasingly popular, such as Aragon and Colony. Selecting the best fitting platform is challenging for organizations, as a significant number of decision criteria, such as popularity, developer availability, governance issues and consistent documentation of such platforms, should be considered. Additionally, decision-makers at the organizations are not experts in every domain, so they must continuously acquire volatile knowledge regarding such platforms.
Objective: Supporting decision-makers in selecting the right decentralized autonomous organization platforms by designing an effective decision model is the main objective of this study. We aim to provide more insight into their selection process and reduce time and effort significantly by designing a decision model.
Method: This study presents a decision model for the decentralized autonomous organization platform selection problem. The decision model captures knowledge regarding such platforms and concepts systematically. This model is based on an existing theoretical framework that assists software engineers with a set of multi-criteria decision-making problems in software production.
Results: We conducted three industry case studies in the context of three decentralized autonomous organizations to evaluate the effectiveness and efficiency of the decision model in assisting decision-makers. The case study participants declared that the decision model provides significantly more insight into their selection process and reduces time and effort.
Conclusion: We observe in the empirical evidence from the case studies that decision-makers can make more rational, efficient, and effective decisions with the decision model. Furthermore, the reusable form of the captured knowledge regarding decentralized autonomous organization platforms can be employed by other researchers in their future investigations.

1. Introduction

First Bitcoin in 2008 [1], and later Ethereum in 2014 [2], held a powerful promise: decentralized governance, without third-party authorization, not just for finance applications such as cryptocurrencies but for any organizations. Decentralized Autonomous Organizations (DAOs) are expected to enable people to organize online, relying on blockchain-based systems and smart contracts and automating their governance [3].

A variety of DAOs have emerged to facilitate the deployment of DAOs on blockchain platforms by reducing the required technological knowledge and providing DAO software as service platforms, such as Aragon[1], DAOstack[2] and Colony[3]. These DAO platforms enable users without technical knowledge on blockchain to create a DAO using a customizable

* Corresponding author.
E-mail addresses: e.baninemeh@uu.nl (E. Baninemeh), s.farshidi@uu.nl (S. Farshidi), slinger.jansen@uu.nl (S. Jansen).

[1] lhttps://aragon.org/.
[2] lhttps://daostack.io/.
[3] lhttps://colony.io//

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template [4]. A significant number of DAO platforms with a broad list of features and criteria are available in the market. This study focuses on these particular DAO platforms. Selecting the best fitting platform is challenging for organizations, as a significant number of decision criteria, such as popularity, developer availability, governance issues and consistent documentation of such platforms, should be considered. Additionally, decision-makers at the organizations are not experts in every domain, so they must continuously acquire volatile knowledge regarding such platforms and keep themselves updated. Accordingly, a decision model is required to analyze the decision criteria using systematic identification and evaluation of potential alternative solutions for organizations. The object of this study is the DAO platform selection process that took place when the DAO was founded.

Technology selection problems in the software production domain can be modeled as a Multi-Criteria Decision-Making (MCDM) problem that deals with evaluating a set of alternatives and considering a set of decision criteria [5]. Recently, we introduced a technology selection framework [6] that is used to build decision models for MCDM problems and assist decision-makers at software-producing organizations with their decision-making processes [6]. Additionally, we have designed and implemented a Decision Support System (DSS) [7,8] for supporting decision-makers with their MCDM problems in software production. The DSS provides a decision model studio[4] for building decision models based on the technology selection framework. Such decision models can be uploaded to the knowledge base of the DSS to facilitate the decision-making process for software-producing organizations according to their requirements and preferences. The DSS provides a discussion and negotiation platform to enable decision-makers at software-producing organizations to make group decisions. Furthermore, the DSS can be used over the entire life-cycle and co-evolve its advice based on evolving requirements.

In this study, the DAO platform selection process is modeled as an MCDM problem, and the technology selection framework is employed to build a decision model for this MCDM problem. Three industry case studies have been conducted to evaluate the efficiency and effectiveness of the decision model in assisting DAOs. With empirical evidence from the case studies, we find that decision-makers can make more rational, efficient, and effective decisions with the decision model to meet their requirements and priorities.

We serve two audiences with this work. Firstly, researchers can use the feature model about DAO platforms as a starting point for their own research into DAOs and the degrees of freedom in DAO design. Furthermore, researchers can use the empirical evidence about the cases as proof that MCDM is a reliable technique for complex technology decision processes in organizations. Secondly, the article promotes the MCDM DAO platform selection tool to practitioners, who are free to use the main artifact produced in this study and are interested in the aspects they should consider when designing a DAO or selecting a DAO platform.

The structure of this article is as follows. Section 2 describes layers of the blockchain technology stack and positions the DAO platform selection problem among other blockchain technology selection problems in this domain. Section 3 formulates the DAO platform selection problem as an MCDM problem, defines the study's research questions, and explains our research method based on the design science, expert interviews, document analysis, and case studies. This study reports on the following contributions.

- Section 4 elaborates on how we have mapped the implicit knowledge of DAO experts to the explicit knowledge of DAO platforms that we have captured based on an extensive literature study. The outcome of the different features that we identify about DAO platforms can be used by researchers in the future, as it provides a comprehensive overview of the features that DAO platforms must support.
- Section 5 explains our empirical observations in the context of three real-world case studies that have been conducted to evaluate the effectiveness and usefulness of the decision model in addressing the DAO platform selection problem.
- Section 6 shows the case studies' results and compares the DSS outcomes with the case study participants' shortlists of feasible DAO platforms. The results show that the DSS recommended nearly the same solutions as the case study participants suggested to their organizations after extensive analyses and discussions and does so more efficiently.

Section 7 highlights barriers to the knowledge acquisition and decision-making process, such as motivational and cognitive biases, and argues how we have minimized these threats to the validity of the results. Section 8 positions the proposed approach in this study among the other DAO platform selection techniques in the literature. Section 9 summarizes the proposed approach, defends its novelty, and offers directions for future studies.

2. Background: Decentralized autonomous organizations

No widely accepted definition for DAO has been suggested in the literature. For instance, Buterin [9] explained DAOs as a way to explore those new governances of organizations' rules that could be automated and transparently embedded in a distributed ledger. Alternatively, Dhillon et al. [10] defined it as a blockchain entity built on a consensus of decisions by members of DAO. DAOs are virtual organizations working through rules encoded as computer programs, also called smart contracts [11]. This form of management also features lower administration costs compared to traditional organizations as many functions are handled by the blockchain itself [12]. DAOs are organizations in the sense that they mediate the interactions of a group of people, typically an open community that joins as members. In some DAOs, members are token holders [13] of a specific token that enables DAO participation, similar to corporation shares [14].

The comparative advantages of DAOs are that they permit (1) a higher degree of anonymity, (2) permission-less access and use, and (3) commitment to contractual terms (smart contracts) [15]. The benefits of DAOs are, first and foremost, a significant reduction in internal and external transaction costs, including costs associated with managing and maintaining management control systems. The various procedures of coordination, confirmation, verification, approval, and the adoption of typical (standard) management decisions are unified and automated [16].

Traditional organizations are regulated by laws and legal contracts that are enforced by a country's legal system [17]. Conversely, DAOs can be governed by a set of agreed-upon rules postulated in an open-source protocol or a smart contract that can only be modified by the majority rule, agreed upon by its founding members [18]. In addition, as DAO usually operates under the regulation rules and collaboration patterns defined by all stakeholders, consensus and trust within a DAO are easier to achieve. Thus, trust, communication and transaction costs would be minimized [19].

A blockchain technology stack can be modeled to distinguish such applications and protocols. Each layer of the stack inherits the protocols and rules of the layer below. Fig. 1 illustrates the blockchain technology stack, which consists of the following three main layers: the Internet, blockchain, and application layers [20].

2.1. The application layer

Generally speaking, an application layer is an abstraction level that masks the technical details of a communication channel and serves as a user interface on a network. The application layer in the blockchain technology stack focuses on developing blockchain solutions across different applications and industries. This layer contains Decentralized

[4] https://dss-mcdm.com/.

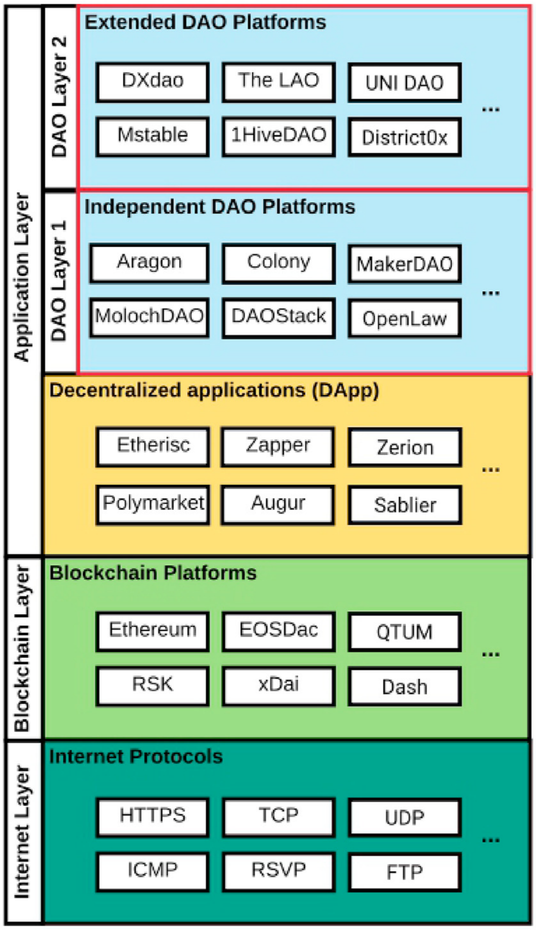

Fig. 1. The layers of the blockchain stack. Adopted from Ref. [21] with permission.

Application (DApp), DAO Layer 1, and DAO Layer 2.

2.1.1. DAO layer 1

The development process of a DAO is significantly complicated, even for experienced software practitioners. One of the fundamental challenges for the Ethereum community is the lack of compliance standards and practical use cases of DAOs deployed on the blockchain, particularly when comparing their added value (e.g., efficiency or new services) to traditional and centralized organizations. In response to this issue, some open-source software frameworks or independent DAO platforms have emerged to facilitate the implementation of DAOs [3].

These platforms that provide DAO deployment as a service allow users with insufficient knowledge of how blockchain works to create a DAO using a template that typically can be customized [22].

Independent DAO platforms are no-code platforms (such as Aragon, DAOstack, DAOhaus, and Colony) and provide tools to coordinate community resources allocation without the need for a central point of contact and a high degree of technical aptitude. For instance, Aragon is a software framework or independent DAO platform oriented to developing DAOs built on the Ethereum platform and creating configurable governance structures [23]. DAOstack is another example of such independent DAO platforms. It is an open-source, modular DAO project, which leverages the technology and adoption of decentralized governance, enabling people to create DApps, DAOs, and DAO tools [24]. As the last example, Colony is a DAO framework based on a reputation system (the user reputation weights, i.e., decision power). The Colony network is composed of a suite of smart contracts which are deployed on the Ethereum blockchain [3].

2.1.2. DAO layer 2

Extended DAO platforms have been developed based on DAO platforms of layer 1. For instance, the dxDAO is built on top of DAOstack, and Reputation is the intrinsic DAOstack. District0x is a platform of decentralized markets built based on Aragon.

Initially, organizations can build their own DAO by using the DAO platforms of layer 1 and then extending it based on the services offered by DAO platforms of layer 2. For instance, Aragon-based DAOs can extend their functionality using pre-installed Aragon apps or modules as following [25]: *Tokens* manage membership and voting power in a DAO, with the ability to mint (i.e., create) new tokens, assign existing tokens, and create vestings (i.e., tokens that are held aside for a while for the team, partners, advisors, and others who are contributing to the development of the project, and that can be released later); *voting mechanisms* create votes that execute actions on behalf of token holders, with the ability to see all open and closed votes, start a new vote and token poll holders in a DAO about a specific issue; *finance management modules* handle assets of a DAO, budget expenses, and record final transactions to have a history of past transfers, with the ability to create new transfers from this module; *agents* interact directly with any other smart contract on the Ethereum platform.

3. Research approach

This section outlines the research questions and elaborates on a mixed research method. We combined design science research, expert interviews, documentation analysis, and case study research to capture knowledge regarding DAO platforms, answer the research questions, and build a decision model for the DAO platform selection problem.

3.1. Problem definition

In this study, we formulate the DAO platform selection problem as an MCDM problem.

Let $Platforms = \{p_1, p_2, \ldots, p_{|Platforms|}\}$ be a set of DAO platforms in the market (i.e., Aragon, DAOStack, and Colony). Furthermore, let $Features = \{f_1, f_2, \ldots, f_{|Features|}\}$ be a set of DAO features (i.e., decentralization types, voting mechanism) of the DAO platforms, and each platform p, where $p \in Platforms$, supports a subset of the set *Features*. The goal is finding the best fitting DAO platforms as *Solutions*, where $Solutions \subset Platforms$, that support a set of DAO feature requirements, called *Requirements*, where $Requirements \subseteq Features$. An MCDM approach for the selection problem receives *Platforms* and their *Features* as its input, then applies a weighting method to prioritize the *Features* based on the preferences of decision-makers to define the *Requirements*, and finally employs a method of aggregation to rank the *Platforms* and suggests *Solutions*. Accordingly, an MCDM approach for the DAO platform selection problem can be formulated as follows:

$$MCDM : Platforms \times Features \times Requirements \rightarrow Solutions \tag{1}$$

Typically, a unique optimal solution for an MCDM problem, including DAO platform selection, does not exist, and it is essential to apply decision-makers' preferences to differentiate between solutions [26]. Particular DAO platforms might fit into an organization; however, some might be better than others. It is tough to state which DAO platform is the best, partially because we can not predict the future or know how the organizations would have evolved if a different DAO platform was selected. Moreover, we must note that such a technology selection process can never be completely objective because humans have to make decisions as the main decision-makers. Fig. 2 visualizes the MCDM approach for the DAO platform selection problem in a 3D space. It shows that the degree of satisfaction of the decision-makers with a suggested solution is fuzzy, which means that the satisfaction degree from a decision-maker perspective may range between completely true (best fit)

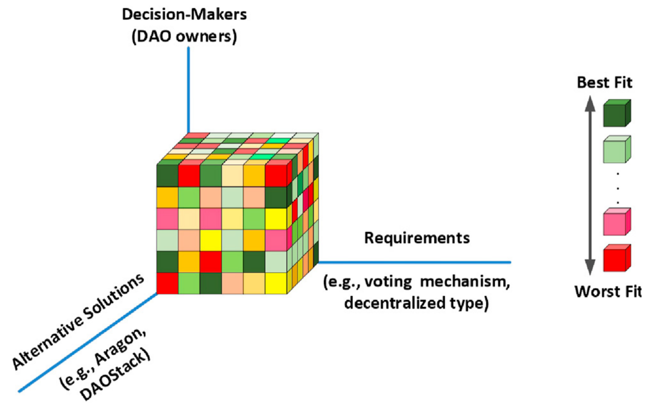

Fig. 2. An MCDM approach for the DAO platform selection problem in a 3-dimensional space. Note that the degree of the decision-makers' satisfaction with a solution according to their priorities and requirements (e.g., voting mechanism, decentralized type) ranges between the best and worst fit solutions (e.g., Aragon, DAOStack), which is represented by a range of colors from red to dark green.

and completely false (worst fit) [27], which is represented by a range of colors from red to dark green.

3.2. Research questions

The Main Research Question (MRQ) of this study is as follows.

MRQ: How to support decentralized autonomous organizations with the decision-making process in selecting the fitting platform by knowledge required capturing?

We formulated the following research questions to answer the main research question.

***RQ*$_1$:** Which DAO platforms should be considered in the decision model?

***RQ*$_2$:** Which characteristics of DAOs should be considered as DAO features in the decision model?

***RQ*$_3$:** Which software quality attributes can be used to evaluate DAO platforms?

***RQ*$_4$:** What are the impacts of DAO features on the quality attributes of DAO platforms?

***RQ*$_5$:** Which DAO platforms currently support the features that we considered in our research?

3.3. Research method

Research methods are classified based on their data collection techniques (interview, observation, literature, etc.), inference techniques (taxonomy, protocol analysis, statistics, etc.), research purposes (evaluation, exploration, description, etc.), units of analysis (individuals, groups, process, etc.), and so forth [28]. Multiple research methods can be combined to achieve a fuller picture and a more in-depth understanding of the studied phenomenon by connecting complementary findings that are concluded from the methods from the different methodological traditions of qualitative and quantitative investigation [29].

The framework provides a guideline for decision-makers to build decision models for MCDM problems in software production following the six steps of the decision-making process [30]: (1) identifying the objective, (2) selection of the features, (3) selection of the alternatives, (4) selection of the weighing method, (5) applying the method of aggregation, and (6) decision making based on the aggregation results. This study used the framework to build a decision model for the DAO platform selection problem. We employed design science, expert interviews, and document analysis as a mixed data collection method to capture DAO platforms' knowledge and answer the research questions.

3.3.1. Design science

Design science is an iterative process [31] that has its roots in engineering [32], is broadly considered a problem-solving process [33], and tries to generate generalizable knowledge concerning design processes and design decisions. The design process is a collection of hypotheses that can ultimately be proven by developing the artifact it describes [34]. The research approach for building decision models for MCDM problems in software production is design science, which addresses research by developing and evaluating artifacts to meet defined business requirements [35].

In the previous study, we designed a theoretical framework and implemented a DSS for supporting software practitioners with their MCDM problems in software production. This study employs the same framework to build a decision model for the DAO platform selection problem. Additionally, we employed the DSS to reduce the cost of the decision-making process.

3.3.2. Expert interviews

Expert Interview is an essential knowledge acquisition technique [36] in qualitative research. The main source of knowledge to build a decision model is domain expertise. A series of qualitative semi-structured interviews based on Myers' and Newman's guidelines [37] has been conducted to explore tacit knowledge of domain experts regarding DAO platforms and evaluate the outcomes of our study. Ten domain experts, including DAO developers, decentralized autonomous organizations, and blockchain experts from different organizations, have participated in the research to assist us with answering the research questions. Note that this set of interviews was different from the interviews we conducted with the case study participants during the case study research.

Before contacting potential domain experts, a role description was developed to identify their expertise and ensure the right target group. Next, we contacted the selected experts by email using the role description and information about our research topic. Note, the expert selection process has been done pragmatically and conveniently based on the experts' reported expertise and experience mentioned on the *LinkedIn* profile. We considered a set of expert evaluation criteria (including "years of experience", "expertise", "skills", "education" and "level of expertise") to select the experts.

Each expert interview followed a semi-structured interview protocol (see Appendix A) and lasted between 45 and 60 min. Additionally, we used a number of open questions to elicit as much information as possible from the experts, minimizing prior bias. All interviews were done virtually through meeting platforms, such as Skype and Zoom, and recorded with the interviewees' permission, and then transcribed for further analysis.

Captured knowledge after each interview was typically propagated to the next one to validate the acquired knowledge incrementally. Finally, our findings and interpretations were returned to the interview participants for their final approval. Note, for the validity of the results, the research's data collection phases were not affected by the case study participants; furthermore, none of the interviewees or researchers were involved in the case studies.

3.3.3. Document analysis

Document analysis is a systematic procedure for reviewing or evaluating documents, including manuscripts and illustrations, that have been published without a researcher's intervention [38]. Document analysis is one of the analytical methods in qualitative research that requires data investigation and interpretation to elicit meaning, gain understanding, and develop empirical knowledge [39].

There is not a significant number of academic literature available about DAO platforms and related concepts due to their novelty and, in part, due to the fast growth and development of the industry. For this reason, we have also added gray literature to our knowledge base, which significantly increased the amount of information we could find. Around 59% of the sources are web pages, 11% are peer-reviewed articles, and

16% are documentation of the platforms themselves. The rest (14%) are a collection of videos, white papers, forum discussions, and books.

It is essential to highlight that the selected sources of knowledge in the document analysis phase of this research that discuss the DAO platforms are spread across the early years of the emergence of the DAO concepts (2014) [9] to the present (2022). In these sources, we specifically identified features from each of the platforms.

Additionally, we investigated existing trends among software practitioners and researchers in selecting DAO platforms. We observed that DAO platforms and their selection process gained more attention in the past four years.

We created an extraction form to collect knowledge, ensure that it is consistent with relevant knowledge and check if the gathered knowledge answered the research questions. The collected knowledge, which corresponds to the research questions, has been classified into five categories: *DAO platforms*, *DAO features*, *mapping among the DAO features and the quality attributes*, *quality attributes* and *mapping among the DAO features and the DAO platforms*.

3.3.4. Case study

Case study research [40] is an empirical methodology that investigates a phenomenon within a particular context in the domain of interest. Using interviews, case study research can be employed to collect data regarding a particular phenomenon or to apply and evaluate a tool to understand its efficiency and effectiveness. Yin [41] identified four types of case study designs based on holistic versus embedded and single versus multiple. This study employs multiple case designs: examining multiple real-world decentralized autonomous organizations as multiple cases within their context to understand one specific unit of analysis and evaluate the decision model for the DAO platform selection problem. Furthermore, our work has been evaluated using the ACM SIGSOFT Empirical Standards[5] for case studies and case synthesis.

Objective: Building a valid decision model for the DAO selection problem was the main goal of this research.

The cases: The analysis units were three industry case studies, performed in the Netherlands, the United States, and Iran, in the context of three decentralized autonomous organizations.

Methods: We conducted multiple expert interviews with the case study participants to understand their requirements, concerns, and preferences regarding the DAO platform selection problem.

Selection strategy: In this study, we selected multiple case study [42] to analyze the data both within each situation and across situations, to more extensively exploring the research questions and theoretical evolution, and to create a more convincing theory.

Theory: The proposed decision model is a valid reference model to support decentralized autonomous organizations with the DAO platform selection problem.

Protocol: To conduct the case studies and evaluate the proposed decision model, we followed the following protocol.

Step 1. Requirements elicitation: The participants defined their DAO language feature requirements and prioritized them based on the *MoSCoW* prioritization technique [43]. Furthermore, they identified a set of DAO platforms as potential solutions for their DAOs.
Step 2. Results and recommendations: We defined three separate cases in the knowledge base of the DSS according to the case studies' requirements and priorities. Next, the DSS recommended a set of feasible DAO platforms as alternative solutions per case individually. Finally, the outcomes were discussed with the case study participants.
Step 3. Analysis: We compared the DSS suggested feasible solutions with the case study participants' preselected solutions that they had suggested to their organizations based on extensive analysis. Furthermore, we analyzed the outcomes and observations, then reported them to the case study participants and received their feedback on the results.

4. Multi-criteria decision-making

Researchers have introduced a variety of MCDM approaches in the literature. A subset of selected MCDM methods is presented as follows. The Weighted Sum Model (WSM) is an aggregation function that transforms multiple criteria into a single value by multiplying each criterion by a weighting factor and summing up all weighted criteria. The Analytic Hierarchy Process (AHP) is a structured and well-known method for organizing and analyzing MCDM problems based on mathematics and psychology. The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is an MCDM approach that employs information entropy to assess alternatives. The Boolean Decision Tree (BDT) is an MCDM method to choose one of the available and feasible decision alternatives.

We follow the framework [44] as modeled in Fig. 3 to build a decision model for the DAO platform selection problem. The framework incorporates the six-step decision-making process [45]: 1) identifying the objective, 2) selecting features, 3) selecting alternatives, 4) selecting a weighing method, 5) applying a method of aggregation, and 6) making decisions based on the aggregation results. Based on the framework, the primary sources of knowledge for defining Steps 1, 2, and 3 are research papers, ISO standards [46,47], DAO platform websites and white papers, and domain experts. The MCDM framework employs the MoSCoW prioritization technique as its weighting method (Step 4), and uses the WSM as its aggregation method [6] (Step 5). Finally, the decision-making results will be inferred by the inference engine of the DSS (Step 6). Generally speaking, a decision model for an MCDM problem contains decision criteria, alternatives, and mappings. Fig. 3 represents the main building blocks of the decision support system besides the proposed decision model.

4.1. RQ1: Which DAO platforms should be considered in the decision model?

We identified 90 DAO platforms as our initial hypothesis and ended up with 28 based on literature and expert interviews to answer the first research question. Accordingly, we explored literature based on the following search keywords: "DAO", "DeFi", "DAO As Service", and "decentralized autonomous organization" platforms. Additionally, we exploit our network of domain experts, including software engineers and academics. We reviewed the published surveys and reports from well-known communities, including Medium [48], Github [49], IEEE [50], Hackernoon [51], YouTube [52], LinkedIn [53], Twitter [54], Springer [55], Reddit [56], and Messari [57].

We conducted interviews with ten experts to gain more insight into the popular and applicable DAO platforms and evaluate our findings. It is interesting to highlight that most of the domain experts were familiar with a limited number of the DAO platforms (see the ten domain experts' columns on Table 1). We only considered the DAO platforms mentioned on at least five sources of knowledge (including communities and domain experts) to prevent potential biases. Finally, we analyzed the data and ended with 28 alternative DAO platforms mentioned on at least three resources. Table 1 shows the complete list of the DAO platforms we selected in the decision model.

4.2. RQ2: Which characteristics of DAOs should be considered as DAO features in the decision model?

Domain experts were the primary source of knowledge to identify the right set of DAO features, even though documentation and literature studies of DAO platforms can be employed to develop an initial hypothesis about the DAO feature set. Each DAO feature has a data type, such as Boolean and non-Boolean. For example, the data types of DAO

[5] https://github.com/acmsigsoft/EmpiricalStandards.

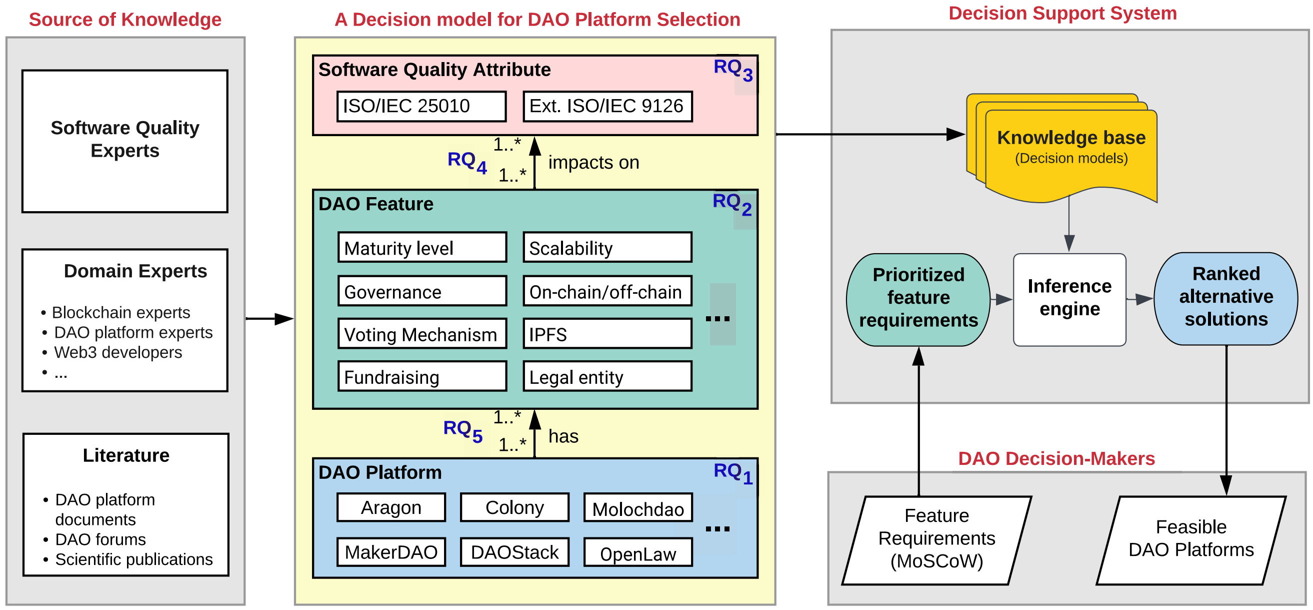

Fig. 3. The main building blocks of the decision support system besides the proposed decision model for the DAO platform selection problem. Adapted from previous study [8].

features, such as the popularity in the market and supportability of Quadratic voting, can be considered as non-Boolean and Boolean, respectively.

The initial DAO features were extracted from the following sources: web pages, white papers, scientific papers, documentation, forum discussion, books, videos and dissertations. In our initial list, we distinguished 118 Boolean and ten non-Boolean features. Afterward, ten domain experts participated in this research phase to identify a potential list of DAO features.

Accordingly, 77 Boolean and five non-Boolean DAO features[6] were identified and extracted from the outcomes of the expert interviews. Eventually, the domain experts evaluated and confirmed the validity and reliability of the final list of the DAO features.

4.3. RQ3: Which software quality attributes can be used to evaluate DAO platforms?

According to IEEE Standard Glossary of Software Engineering Terminology [58,59], the quality of software products is a model to which a system, component, or process meets defined requirements (such as availability, scalability, security and operability) and the degree to which a system, component or process addresses the requirements or expectations of a user. Finding quality attributes widely supported by other researchers to estimate the system's characteristics is essential.

The *ISO/IEC 25010* [47] presents best practice recommendations based on a quality assessment model. The quality model defines the quality characteristics to consider when assessing a software product's properties. A set of quality attributes should be specified in the decision model. In this study, we used the *ISO/IEC 25010* standard [47] and *extended ISO/IEC 9126* standard [46] as two domain-independent quality models to investigate DAO features based on their impact on quality attributes of DAO platforms. The key rationale behind employing these software quality models is that they are standardized to measure a software product. Furthermore, they explain how efficiently and reliably a software product can be used.

[6] The entire lists of the DAO features and their mapping with the considered DAO platforms are available and accessible on the *DAO Platform Selection* website (https://dss-mcdm.com).

The literature study results show that researchers and practitioners do not agree upon standard criteria for assessing DAO platforms, including quality attributes and features (see Table 7).

The last columns of Table 7 denote the outcomes of the analysis concerning the common criteria and alternatives of this study with the selected studies. Let us define the coverage of the i-th selected study as follows:

$$Coverage_i = \frac{CQ_i + CF_i}{C_i} \times 100,$$

where CQ_i and CF_i signify the numbers of common quality attributes (column #CQ) and features (column #CF) of the i-th selected study, respectively, and C_i defines the number of suggested criteria by the i-th selected study. The last column (*Cov.*) of Table 7 shows the percentage of the coverage of the considered criteria within the selected studies. On average, 79.24% of those criteria are already considered in this study.

4.4. RQ4: What are the impacts of DAO features on the quality attributes of DAO platforms?

The mapping between the sets *software quality attributes* and *DAO platforms* was identified based on domain experts' knowledge. Four domain experts participated in this phase of the research to map the DAO (*Features*) to the quality attributes (*Qualities*) based on a Boolean adjacency matrix (*Qualities* × *Features* → *Boolean*). For instance, *Infrastructure decentralization* as a DAO feature influences the *Operability* quality attribute. After analyzing the mapping, we realized that the DAO features have significant impacts on the following set of quality attributes.

- **Functional appropriateness** is defined in ISO/IEC 25010 as the degree to which the functions of DAO platforms facilitate the accomplishment of specified tasks and objectives.
- **Operability** is the degree to which a DAO platform has attributes that make it easy to operate and control.
- **Interoperability** defines the degree to which two or more DAO platforms can exchange information and use the information that has been exchanged.
- **Functional correctness** defines the degree to which a DAO platform provides the correct results with the needed degree of precision.
- **Ownership** attributes concerning intellectual property rights.

Table 1
The DAO platforms mentioned at least five sources of knowledge (communities and domain experts) and are considered potential alternatives. The agreement column on each row indicates the percentage of well-known corresponding platforms by communities and domain experts. For instance, for the first row (Aragon), we reviewed all the documents, posts, comments, contexts, etc., in the following communities that are mentioned in the table, such as Medium, Reddit, etc. Furthermore, when we interviewed the ten experts about these DAO platforms in the list, they were familiar with Aragon, so the agreement value for this platform is 100%.

	Agreement	*Medium*	*Hackernoon*	*Github*	*IEEE*	*Youtube*	*LinkedIn*	*Twitter*	*Springer*	*Reddit*	*Messari*	*DomainExpert1*	*DomainExpert2*	*DomainExpert3*	*DomainExpert4*	*DomainExpert5*	*DomainExpert6*	*DomainExpert7*	*DomainExpert8*	*DomainExpert9*	*DomainExpert10*
Aragon	100.00%	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Colony	95.00%	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DAOStack	95.00%	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	✓
MakerDAO	70.00%	✓	✓	×	✓	×	✓	✓	✓	✓	✓	✓	×	×	✓	×	×	✓	✓	✓	✓
Holochain	60.00%	✓	✓	✓	×	✓	✓	✓	×	×	✓	✓	✓	✓	✓	×	×	×	×	✓	×
Molochdao	60.00%	✓	✓	✓	✓	×	×	✓	✓	✓	×	✓	✓	✓	✓	×	×	×	×	×	✓
OpenLaw	60.00%	✓	✓	✓	×	✓	✓	✓	✓	×	✓	✓	×	×	✓	×	×	×	✓	×	✓
Daohaus	55.00%	✓	×	✓	✓	×	×	✓	✓	×	✓	✓	✓	×	✓	×	✓	×	✓	×	×
1Hive DAO	55.00%	✓	✓	✓	×	✓	✓	✓	✓	×	×	×	✓	✓	✓	✓	×	×	×	×	×
Nexus mutual	55.00%	✓	✓	✓	×	✓	✓	✓	×	×	✓	✓	×	✓	×	×	✓	×	×	×	✓
Compound	55.00%	✓	✓	✓	×	✓	✓	✓	×	✓	✓	✓	×	×	×	×	✓	×	×	×	✓
The Commons Stack	50.00%	✓	×	✓	×	✓	✓	✓	×	×	×	✓	✓	✓	✓	×	×	×	×	✓	×
Pocket Network	45.00%	✓	×	✓	×	✓	✓	✓	×	×	✓	×	✓	×	✓	×	✓	×	×	×	×
The LAO	45.00%	✓	×	✓	×	×	×	✓	✓	×	×	✓	✓	×	✓	×	✓	×	×	×	✓
DXdao	45.00%	✓	✓	×	×	✓	×	✓	×	✓	✓	×	✓	×	✓	×	×	✓	×	×	×
BalancedDAO	45.00%	✓	✓	✓	×	×	×	✓	×	✓	×	×	✓	×	✓	×	✓	✓	×	×	×
Mstable DAO	45.00%	✓	×	✓	×	✓	✓	✓	×	×	✓	×	✓	×	✓	×	×	×	✓	×	×
Wings	40.00%	✓	✓	✓	×	×	×	✓	×	×	✓	×	✓	×	✓	×	✓	×	×	×	×
Kleros	40.00%	✓	✓	×	×	×	✓	✓	×	×	✓	✓	✓	×	✓	×	×	×	×	×	×
Ventuary DAO	40.00%	✓	×	×	×	×	✓	✓	✓	✓	×	×	✓	×	✓	×	✓	×	×	×	×
MetaCartel	40.00%	✓	✓	✓	✓	×	×	✓	×	×	✓	×	✓	×	✓	×	×	×	×	×	×
UNI DAO	40.00%	✓	×	✓	×	✓	×	✓	×	×	×	×	✓	×	✓	×	✓	×	×	✓	×
GovBlocks	40.00%	✓	×	✓	×	✓	✓	✓	×	×	×	✓	×	×	×	✓	×	×	×	✓	×
Infinity economics	35.00%	✓	×	✓	×	×	×	✓	×	×	✓	×	✓	×	✓	×	✓	×	×	×	×
WhalerDAO	35.00%	✓	×	✓	×	✓	×	✓	×	×	×	×	✓	×	✓	✓	×	×	×	×	×
SourceCred	35.00%	✓	×	✓	×	✓	×	✓	×	✓	×	✓	×	×	×	×	×	✓	×	×	×
PhutureDAO	30.00%	✓	×	×	×	×	×	✓	×	✓	×	×	×	×	✓	✓	×	×	×	×	✓
Tezos	25.00%	✓	×	×	×	×	✓	✓	×	×	✓	×	×	×	✓	×	×	×	×	×	×
Daohub	25.00%	×	×	✓	×	×	×	×	✓	×	×	×	✓	×	✓	×	✓	×	×	×	×

- **Functional completeness** is the degree to which the set of functions of DAO platforms covers all the specified tasks and user objectives.

The acquired knowledge regarding the impacts of the DAO features on the quality attributes was used to calculate the Impact Factors that apply in the score calculation of the DSS. The framework does not enforce a DAO feature to present in a single quality attribute; DAO features can be part of many quality attributes. For example, Token distribution as a feature might connect to multiple quality attributes such as Interoperability, Operability, and Functional correctness.

4.5. RQ5: Which DAO platforms currently support the features that we considered in our research?

A DAO platform contains a set of DAO features that can be either Boolean or non-Boolean. A Boolean DAO feature ($Feature^B$) is a feature that is supported by the DAO platform, for example, the *Quadratic Voting*. A non-Boolean DAO feature ($Feature^N$) assigns a non-Boolean value to a particular DAO platform; for example, the popularity in the market of a DAO platform can be "high", "medium", or "low". Accordingly, this study's DAO features are a collection of Boolean and non-Boolean features, where $Features = Feature^B \cup Feature^N$.

The mapping BFP: $Feature^B \times Platforms \rightarrow \{0, 1\}$ defines the supportability of the Boolean DAO features by the platforms. So that $BFP(f, p) = 0$ means that the platform p does not support the DAO feature f or we did not find any evidence for proof of this feature's supportability by the DAO platform. Moreover, $BFP(f, l) = 1$ signifies that the platform supports the feature. The mapping BFP is defined based on documentation of the DAO platforms and expert interviews. Tables 3 and 4 present the Boolean features we have considered in the decision model.

The experts defined five non-Boolean DAO features, including "popularity in the market", "maturity level of the company", "developer resources (people)", "upgradability", and "scalability". The assigned values to the non-Boolean DAO features for a specific DAO platform are based on a 3-point Likert scale (**H**igh, **M**edium and **L**ow), where NFP: $Features^N \times Platforms \rightarrow \{H, M, L\}$ is defined, based on several predefined parameters. For instance, the "popularity in the market" of a DAO platform was defined based on the following parameters: the number of "Google hits", "Twitter (followers)", "LinkedIn (followers)", and the popular forums and reports that considered the platform in their evaluation. Table 2 shows the non-Boolean DAO features, their parameters, and sources of knowledge.

4.6. DAO feature requirements

DSS receives the DAO feature requirements based on the *MoSCoW* prioritization technique [43]. Decision-makers should prioritize their DAO feature requirements using a set of weights ($W_{MoSCoW} = \{w_{Must}, w_{Should}, w_{Could}, w_{Won't}\}$) according to the definition of the *MoSCoW* prioritization technique. DAO feature requirements with *Must-Have* or *Won't-Have* priorities act as hard constraints and DAO feature requirements with *Should-Have* and *Could-Have* priorities act as soft constraints. So that the DSS excludes all infeasible DAO platforms which do not support DAO features with *Must-Have* and support DAO features with *Won't-Have* priorities. Then, it assigns non-negative scores to feasible DAO platforms according to the number of DAO features with *Should-Have* and *Could-Have* prioritizes.

5. Empirical evidence: the case studies

We selected 35 companies that used DAO platforms and reviewed the documents we found on their website. Our criteria for selecting the companies as a case study are as follows. 1) Currently, they use DAO layer 1 (mentioned in Section 2), or they will use them. So, after reviewing their documents, we excluded the companies that have not used the DAOs in layer 1 or wanted to develop their own DAO. 2) We also considered the size of the companies on our list. We checked the size of the companies on our list. The size of them was different in the range of 10–500. We excluded the companies that had less than 50 employees. Because we wanted to keep the companies that are well-known and larger on our list. 3) We contacted the companies and asked them if they were interested in participating as a case study in our research. Furthermore, our work has been evaluated using the ACM SIGSOFT Empirical Standards[7] for case studies and case synthesis. Finally, we ended up with three case studies on our list. Three industry case studies have been conducted to evaluate and signify the decision model's efficiency and effectiveness in addressing the DAO platform selection problem. The case study organizations are from three different domains, including Web3 development, open-source software security, and decentralized finance (DeFi), for increasing variety in our evaluation. Moreover, the selected case study organizations were located in three countries: the United States, Iran, and the Netherlands.

5.1. Case study 1: dOrg

dOrg is a decentralized autonomous collective of developers specialized in Web3 design and development that works with industry projects. dOrg is a freelancer collective with over 25 members that work remotely to build solutions for DApps, smart contracts, prototypes, and experiences. The collective is run in a decentralized manner by worldwide DAO builders through smart contracts. In other words, dOrg is a cooperative of blockchain software engineers that build DAO-related softwares. dOrg provides the DAO with continuous product development and operational support services. The dOrg team demonstrated how a DAO could have official legal status, allowing DAOs to enter contractual agreements and offer participants liability protections.

Their rigorous freelancer activation process and transparent workflow have resulted in collaborations with crypto brands such as Gnosis, eToro, Balancer, DAOstack, The Graph, and more. No centralized governing has the authority to control the interaction between freelancers and clients. There is direct contact between freelancers and clients without any middleman. Every freelancer could compete for any consignment posted on the platform. Cryptocurrency helps eliminate frauds involving a repudiation of payment and false claims on assets. The cryptocurrency wallets are secured, and payments can only be made by the wallet owner and do not need any information to be shared with any intermediary. The payments are made between crypto wallets which are highly secured by cryptographic keys. The network can be trusted because every transaction is verified by the network and subsequently written on an immutable ledger. The smart contracts release payments instantly once the transaction conditions are satisfied and there are no intermediate holders to delay payments. Anyone can apply for a job from anywhere in the world; there are no limitations on global access and payments. The smart contract holds the security amount and is trusted by both parties involved as it is locked based on mathematical logic. Everyone in the network has access to a distributed ledger to verify that the system is working correctly at any instant. The experts at dOrg stated that they use DAOStack as their selected DAO platform to develop DAOs for their clients.

5.1.1. Requirements

The experts at dOrg defined the following subset of requirements for their DAO (for more detail, see Table 5).

- The dOrg needs the DAO that people decide on policy initiatives directly (R03).
- The DAO must be able to use on-chain resources to allow a DAO to directly exert control and initiate action via a smart contract (R14, R15).

[7] https://github.com/acmsigsoft/EmpiricalStandards.

Table 2
The **NFA** mapping between the **N**on-Boolean DAO **F**eatures and **A**lternatives.

NFA (5)	Aragon	Colony	MakerDAO	DAOStack	Tezos	Molochdao	Wings	Kleros	Infinity economics	OpenLaw	DXdao	Pocket Network DAO	Holochain	Ventuary DAO	MetaCartel	DaoHub	Daohaus	The Commons Stack	The LAO	BalancedDAO	PhutureDAO	WhalerDAO	UNI DAO	Mstable DAO	GovBlocks	1HiveDAO	Nexus mutual	Compound	Source of Knowledge
Popularity	High	High	High	High	High	Medium	High	Medium	High	Medium	Medium	High	High	Medium	Low	Low	Low	Low	Medium	Low	Low	Low	Medium	Medium	Medium	Low	High	High	Domain Experts
Founded Date	2017	2014	2014	2017	2018	2019	2019	2017	2017	2017	2019	2017	2017	2017	2019	2018	2019	2019	2016	2020	2020	2020	2019	2019	2017	2,018	2,017	2,017	crunchbase.com
Google (#hits)	1110000	1160000	1040000	318000	4700000	108000	10800000	697000	22400000	260,000	950000	2420000	150000	11900	43100	3980	13,300	620,000	306000000	705	8,270	702	91,400,000	876,000	15,000	23,400	12,100,000	156,000,000	Google.com
Twitter (#followers)	72482	8392	47708	7,405	72000	4,899	33807	8785	1,859	8,439	3,683	1208	32900	37700	5,365	N/A	1,349	1,554	3,725	748	471	732	126	11,800	299	2,030	21,500	83,500	Twitter.com
#LinkedIn (followers)	1583	312	4130	467	4141	N/A	N/A	1382	N/A	1,098	N/A	287	1795	25	113	N/A	N/A	115	N/A	N/A	N/A	N/A	N/A	184	225	N/A	515	N/A	LinkedIn.com
Maturity level	High	High	High	High	Medium	Medium	Medium	Medium	Low	Medium	Medium	Medium	Low	Low	Low	Low	Medium	Low	Low	Low	Low	Medium	Medium	Low	Medium	Medium	Low	Low	Domain Experts
Supported features	71.43%	75.32%	61.04%	67.53%	33.77%	48.05%	33.77%	31.17%	29.87%	32.47%	42.86%	42.86%	28.57%	28.57%	25.97%	29.87%	32.47%	23.38%	27.27%	28.57%	24.68%	32.47%	41.56%	27.27%	41.56%	40.26%	29.87%	25.97%	Documention
Developer Resources (People)	High	High	High	High	High	Low	High	Medium	High	High	Low	High	High	Low	High	Low	Low	High	Medium	Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	Domain Experts
Github (#projects)	113	68	N/A	51	N/A	6	10	N/A	14	37	N/A	81	145	N/A	27	13	7	24	36	3	N/A	6	20	13	10	97	15	35	Github.com
LinkedIn (#People)	330000	184000	256	85	553	2	234000	136	6,700	110	2	26185	201	2	19	1	2	14	N/A	N/A	N/A	N/A	N/A	14	9	N/A	3,600	N/A	LinkedIn.com
Upgradability	High	High	High	High	High	High	Low	Low	Low	Low	High	High	High	High	Low	High	Low	Low	Low	Low	Low	Low	Medium	Medium	High	Medium	Medium	Low	Domain Experts
Upgradeable contract	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Documention
Arbitrary transactions	No	Yes	Yes	Yes	No	No	No	Yes	No	No	Yes	No	Yes	No	No	No	No	Yes	No	No	No	No	No	Yes	No	No	No	No	Documention
Onchain tools	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Documention
Offchain tools	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	No	No	Documention
Transparency portal	Yes	Yes	Yes	Yes	No	No	No	No	Yes	No	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	Yes	No	Documention
Domains	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Documention
Scalability	High	High	High	High	High	High	High	Medium	High	Medium	Low	Low	High	High	Medium	High	Low	Medium	Low	High	Medium	Medium	Low	Low	High	Low	Medium	Medium	Domain Experts
Cryptocurrency	N/A	N/A	MKR(Maker)	N/A	XTZ	N/A	WINGS	N/A	XIN	N/A	N/A	N/A	Holo	N/A	Seed	N/A	N/A	N/A	N/A	BWT	PHTR	N/A	N/A	N/A	N/A	HNY(Honey)	NXM	N/A	Documention
The base platform	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	DAOStack	Aragon	N/A	N/A	N/A	N/A	MolochDAO	N/A	MolochDAO	N/A	N/A	N/A	Aragon	Aragon	N/A	Aragon	N/A	N/A	Documention
Smart contracts	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Documention
Extensibility	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	No	Yes	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	Yes	No	No	No	Documention

- The DAO must support those token holders who can become contractors by submitting proposals for their project's funding by using the DAO funds (R18).
- They need to approve the proposal in research & development, service contracts, professional services, reputation and structure-changing proposals in their DAO (R28, R29, R30, R32, R36).
- *Upgradability*, *scalability* and *maturity level* were part of their quality concerns so that they preferred to hire highly mature DAOs (R78, R79, and R80).
- Besides their current knowledge and experience, the developers' availability is an essential factor that profoundly impacts their decision-making process (R82).

5.1.2. Results

The case study participants identified 69 DAO feature requirements, including 17% hard-constraint features (Must-Have) and 83% soft-constraint features (Should-Have and Could-Have). Table 6 shows that Colony was the first, Aragon was the second, and DAOStack was the third feasible platform for this case study.

Table 3
The first part of the Boolean Features (*Feature*^{B}), DAO Platforms (*Platforms*), and the "BFP" mapping. Note that 1s on each row indicate that the corresponding platforms support the DAO feature of that row, and 0s signify that the corresponding platforms do not support that feature or we did not find any strong evidence of their support based on the documentation analysis. Moreover, the rows in black indicate the categories of the features, the rows in blue show the features, and the rows below them are their sub-features. The definitions of the features are available on the data repository [60].

BFA (BooleanFeatures Alternatives)	43.42%	Aragon 77.11%	Colony 81.93%	MakerDAO 69.88%	DAOStack 74.70%	Tezos 38.55%	Molochdao 55.42%	Wings 37.35%	Kleros 36.14%	Infinity economics 34.94%	OpenLaw 34.94%	DXdao 49.40%	Pocket Network DAO 50.60%	Holochain 32.53%	Ventuary DAO 33.73%	MetaCartel 27.71%	DaoHub 32.53%	Daohaus 39.76%	The Commons Stack 26.51%	The LAO 37.35%	BalancedDAO 36.14%	PhutureDAO 31.33%	WhalerDAO 36.14%	UNI DAO 48.19%	Mstable DAO 31.33%	GovBlocks 49.40%	1HiveDAO 46.99%	Nexus mutual 34.94%	Compound 30.12%
Decentralization Types	**89.29%**	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	0	1
Political decentralization	39.29%	1	1	1	1	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	1
Infrastructure decentralization	85.71%	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	0	1	1	1	0	1
Governance	**78.57%**	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	1
Direct DAO Governance	46.43%	1	1	1	1	0	0	1	0	1	0	1	1	0	0	0	0	0	1	1	0	0	1	1	0	0	1	0	0
Representative DAO Governance	7.14%	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Liquid DAO Governance	46.43%	0	0	1	0	1	1	1	1	0	0	0	0	0	0	0	0	1	1	0	1	1	1	0	1	1	0	0	1
Voting Mechanism	**82.14%**	1	1	1	1	1	1	0	1	0	1	1	1	0	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1
Quadratic voting	7.14%	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Conviction voting	21.43%	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0
Reputation-based voting	25.00%	1	1	0	1	0	1	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
Token-weighted Voting	10.71%	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Token-based voting	57.14%	1	1	1	1	0	1	0	1	0	1	1	1	0	0	0	0	1	0	1	1	1	0	1	0	1	1	0	0
TCR Based Voting	10.71%	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0
Delegable Voting	7.14%	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Lazy consensus	10.71%	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Resource Management	**82.14%**	1	1	1	1	1	1	1	1	0	1	1	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1
On-Chain Resources	82.14%	1	1	1	1	1	1	1	1	0	1	1	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1
Upgradeable contract	82.14%	1	1	1	1	1	1	1	1	0	1	1	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1
Off-Chain Resources	35.71%	1	1	1	1	0	1	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
Natural person	25.00%	1	1	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Legal Entity	21.43%	1	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Autonomy (Self-governance)	**100.00%**	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Smart contracts	100.00%	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Arbitrary transactions	28.57%	0	1	1	1	0	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
Rage Quit	10.71%	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
DAO Design Specification	**100.00%**	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Shared Resource	85.71%	1	1	1	1	0	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Funds	82.14%	1	1	1	1	0	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
Physical Asset	7.14%	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Registry	14.29%	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0
Intellectual Property	10.71%	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Proposals	67.86%	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	0	1	0	1	0	1	0	0	1	0	1	0
Research & Development	28.57%	1	1	1	1	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0
Service contracts	7.14%	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Professional services	14.29%	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Content or registry curation	14.29%	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reputation	46.43%	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Meetups	21.43%	1	1	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Reward-for-work proposals	39.29%	1	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0	1	0	1	0
Structure-changing proposals	17.86%	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Funding Queues	21.43%	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reputation system	**32.14%**	1	1	1	1	0	1	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Manual Reputation Flow	25.00%	0	1	1	1	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Automatic Reputation Flow	14.29%	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

Table 4
The second part of the Boolean Features (*Feature*^{B}), DAO Platforms (*Platforms*), and the "BFP" mapping. Note that 1s on each row indicate that the corresponding platforms support the DAO feature of that row, and 0s signify that the corresponding platforms do not support that feature or we did not find any strong evidence of their support based on the documentation analysis. Moreover, the rows in black indicate the categories of the features, the rows in blue show the features, and the rows below them are their sub-features. The definitions of the features are available on the data repository [60].

BFA (BooleanFeatures Alternatives)	43.42%	Aragon 77.11%	Colony 81.93%	MakerDAO 69.88%	DAOStack 74.70%	Tezos 38.55%	Molochdao 55.42%	Wings 37.35%	Kleros 36.14%	Infinity economics 34.94%	OpenLaw 34.94%	DXdao 49.40%	Pocket Network DAO 50.60%	Holochain 32.53%	Ventuary DAO 33.73%	MetaCartel 27.71%	DaoHub 32.53%	Daohaus 39.76%	The Commons Stack 26.51%	The LAO 37.35%	BalancedDAO 36.14%	PhutureDAO 31.33%	WhalerDAO 36.14%	UNI DAO 48.19%	Mstable DAO 31.33%	GovBlocks 49.40%	1HiveDAO 46.99%	Nexus mutual 34.94%	Compound 30.12%
DAO Application	**82.14%**	1	1	1	1	0	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	0	1	1	1	1	1	1	1
Token distribution	67.86%	1	1	1	1	0	1	1	1	1	0	1	1	1	1	0	0	1	0	0	1	0	1	1	1	0	1	0	1
Funds allocation	64.29%	1	1	1	1	0	1	1	1	1	0	1	1	0	0	0	0	1	1	1	1	0	1	1	0	0	1	1	0
Reputation assignment	46.43%	1	1	1	1	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	1	0	1	1	0	1	1	0	0
Collective data curation	25.00%	1	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
External activity	21.43%	1	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
Governance upgrade	32.14%	1	1	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0
Inflation Funding	28.57%	1	1	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
Fundraising	**57.14%**	1	1	1	1	0	1	0	0	1	0	1	1	1	0	1	0	1	0	1	0	1	0	1	0	1	1	0	0
Security Token Offering (STO)	14.29%	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
Utility Token Offering (UTO)	46.43%	1	1	0	1	0	1	0	0	1	0	1	1	0	0	1	0	1	0	1	0	1	0	1	0	0	1	0	0
Initial coin Offering (ICO)	10.71%	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Revenue Sharing	10.71%	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Budget Box	21.43%	1	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Discussion & Negotiation Type	**82.14%**	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	0	1	0	1	1	1	1	1	1	1	0
On-chain	78.57%	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	0
Off-chain	53.57%	1	1	1	1	1	1	0	1	0	1	0	1	1	0	0	1	1	0	1	0	0	0	0	1	1	0	0	0
Linked discretionary	17.86%	0	1	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DAO Member Management	**92.86%**	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
Authorization (Voting Right)	50.00%	1	1	1	1	1	0	0	0	0	1	1	1	0	0	0	1	0	0	1	0	0	0	1	0	1	1	0	1
Membership management	71.43%	1	1	0	0	1	1	0	0	1	1	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0
Authentication/Identification	50.00%	0	0	0	0	1	1	0	0	1	1	0	0	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0
Permissionless	78.57%	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	0	0
Legally proper KYC	14.29%	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
Architecture	**100.00%**	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Independent Platform	75.00%	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	0	1	1	1	0	0	1	0	1	1
Extension	25.00%	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0	0	0	1	1	0	1	0	0
Toolkit	**75.00%**	1	1	1	1	1	1	1	0	1	0	1	1	1	1	0	1	1	0	1	0	1	0	1	1	1	1	1	0
Onchain tools	60.71%	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	1	0	0	0	0	1	0	1	1	1	1	1	0
Offchain tools	57.14%	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	1	1	0	1	0	0	0	1	0	1	1	0	0
Extensibility	42.86%	1	1	1	1	1	1	0	0	1	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0
Transparency portal	28.57%	1	1	1	1	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0
Legal framework	10.71%	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Domains	17.86%	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
General Feautures	**64.29%**	1	1	1	1	1	1	1	0	1	1	0	1	0	1	0	0	0	1	0	1	0	0	1	0	1	1	1	1
Recovery	25.00%	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0
Multiple payment types	28.57%	1	1	0	1	0	1	0	0	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Analytics Dashboard	32.14%	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0	1	1
Decentralized Storage Systems	**82.14%**	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	1	1	1	0	1
IPFS	78.57%	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	0	0	1	1	1	1	1	0	1
Storj	7.14%	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Ethereum Swarm	10.71%	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
Infrastructure (Network)	**92.86%**	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1
Ethereum	89.29%	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0	1	1
RSK	7.14%	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
xDai	39.29%	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	1	0	1	0	1	1	1

Table 5

The DAO feature requirements, based on the MoSCoW prioritization technique (Must-Have (M), Should-Have (S), Could-Have (C) and Won't-Have (W)). Note, the *Coverage* column denotes the percentage of DAO platforms that support each feature. Note that misinterpretation of the priorities, especially for the features not highly supported by DAO platforms, can lead to infeasible solutions. Accordingly, the case study participants revised their priorities from Must-Have to Should-Have or Won't-Have to None (Note that “>S” indicates that Must-have changed to Should-have and “>N” denotes Won't-Have to None).

	Coverage	dOrg	SecureSECO	Aratoo			*Coverage*	dOrg	SecureSECO	Aratoo	
Infrastructure decentralization	85.71%	**M**	**M**	**M**	*R01*	Funding queues	21.43%	**C**	**C**	**S**	*R42*
On-chain	78.57%	**M**	**M**	**M**	*R02*	Reputation assignment	46.43%	**M**		**C**	*R43*
Upgradeable contract	82.14%	**M**	**S**	**M**	*R03*	External activity	21.43%	**S**		**C**	*R44*
Token distribution	67.86%	**M**	**M**	**S**	*R04*	Utility Token Offering (UTO)	46.43%	**C**	**S**	**S**	*R45*
Documentation	100%	**M**	**S**	**M**	*R05*	Off-chain	53.57%	**M**		**C**	*R46*
Scalability	100%	**S**	**M**	**M**	*R06*	Linked discretionary	17.86%	**> S**		**C**	*R47*
Upgradability	100%	**M**	**S**	**M**	*R07*	Authorization (voting right)	50.00%	**S**		**C**	*R48*
Political decentralization	39.29%	**M**	**S**	**S**	*R08*	Legally proper KYC	14.29%	**> S**		**C**	*R49*
Funds	82.14%	**M**	**S**	**S**	*R09*	Domains	17.86%	**S**		**S**	*R50*
Transparency portal	28.57%	**S**	**S**	**M**	*R10*	Recovery	25.00%	**C**	**C**	**S**	*R51*
Token-based voting	57.14%	**> N**	**M**	**M**	*R11*	Ethereum	89.29%	**M**	**C**	**C**	*R52*
Reputation-based voting	25.00%	**M**	**S**	**M**	*R12*	Manual reputation flow	25.00%	**> S**		**> N**	*R53*
Structure-changing proposals	17.86%	**> S**	**C**	**S**	*R13*	Liquid DAO governance	46.43%	**S**		**C**	*R54*
Governance upgrade	32.14%	**C**	**S**	**M**	*R14*	Quadratic voting	7.14%	**C**	**C**	**C**	*R55*
Authentication/Identification	50.00%	**> S**	**> S**	**C**	*R15*	Rage quit	10.71%	**> S**		**C**	*R56*
Extensibility	42.86%	**M**	**C**	**S**	*R16*	Revenue sharing	10.71%			**S**	*R57*
Active community	100%	**M**	**S**	**M**	*R17*	Budget box	21.43%	**C**		**S**	*R58*
Developer resources (people)	100%	**S**	**S**	**S**	*R18*	Multiple payment types	28.57%	**C**	**C**	**C**	*R59*
Direct DAO governance	46.43%	**M**	**S**	**C**	*R19*	IPFS	78.57%	**S**		**C**	*R60*
Smart contracts	100.00%	**C**	**M**	**S**	*R20*	xDai	39.29%	**> S**		**C**	*R61*
Intellectual property	10.71%	**> S**	**C**	**> S**	*R21*	Maturity level	100%	**S**		**C**	*R62*
Research & development	28.57%	**M**	**C**	**M**	*R22*	Popularity in the market	100%	**C**	**S**	**C**	*R63*
Funds allocation	64.29%	**M**	**C**	**C**	*R23*	Representative DAO governance	7.14%	**C**	**C**	**C**	*R64*
Collective data curation	25.00%	**C**	**S**	**S**	*R24*	Conviction voting	21.43%	**C**		**C**	*R65*
Inflation funding	28.57%	**C**	**S**	**M**	*R25*	Content or registry curation	14.29%	**C**	**C**	**C**	*R66*
Permissionless	78.57%	**M**		**S**	*R26*	Meetups	21.43%	**C**	**C**	**C**	*R67*
Onchain tools	60.71%	**S**	**C**	**M**	*R27*	Security Token Offering (STO)	14.29%	**C**		**C**	*R68*
Analytics dashboard	32.14%	**S**	**C**	**S**	*R28*	Initial Coin Offering (ICO)	10.71%	**C**	**C**	**C**	*R69*
Legal entity	21.43%	**> S**	**S**	**C**	*R29*	Independent platform	75.00%			**C**	*R70*
Automatic reputation flow	14.29%	**S**		**> S**	*R30*	Storj	7.14%	**C**		**C**	*R71*
Offchain tools	57.14%	**S**	**C**	**S**	*R31*	Ethereum Swarm	10.71%	**C**		**C**	*R72*
Reputation	46.43%	**M**	**C**	**> N**	*R32*	Token-weighted voting	10.71%				*R73*
Membership management	71.43%	**C**	**S**	**> N**	*R33*	Physical asset	7.14%			**C**	*R74*
Delegatable voting	7.14%	**S**		**C**	*R34*	Extension	25.00%			**C**	*R75*
Lazy consensus	10.71%	**> S**		**S**	*R35*	TCR-based voting	10.71%	**C**		**> N**	*R76*
Arbitrary transactions	28.57%	**C**	**S**	**C**	*R36*	On-chain resources	82.14%			**S**	*R77*
Shared resource	85.71%			**M**	*R37*	Natural person	25.00%			**C**	*R78*
Proposals	67.86%			**M**	*R38*	Legal framework	10.71%				*R79*
Service contracts	7.14%	**> S**	**C**	**C**	*R39*	RSK	7.14%	**C**		**C**	*R80*
Professional services	14.29%	**M**	**C**	**C**	*R40*	Off-chain resources	35.71%			**C**	*R81*
Reward-for-work proposals	39.29%	**C**	**C**	**C**	*R41*	Registry	14.29%				*R82*

Table 6

The context of the case study companies (Context), the feature requirements (Requirements), the case study participants' ranked shortlists (CP). Moreover, the numbers of feature requirements (#Feature Req) and the percentages of the MoSCoW priorities are shown in the table. For instance, the percentage of the Must-Have priority for *dOrg* is 17%, and finally, the outcomes of the DSS for the case studies (DSS Solutions) are shown, which are based on their requirements and priorities. These numbers in percentages in this section of the table signify the calculated scores by the DSS. For instance, the score of the *Aragon* platform for *SecureSECO* is 88%.

Context		Case Study 1		Case Study 2		Case Study 3	
	Company Name	**dOrg**		**SecureSECO project**		**Aratoo**	
	Country	**United States**		**Netherlands**		**Iran**	
	Project Name	**dOrg**		**SecureSECO DAO**		**Akino protocol**	
	Domain	**Web3 development**		**Open source software security**		**Defi (Decentralized finance)**	
	#Decision-Makers	**34 (active) - 50 (reputation holders)**		**4**		**6**	
Requirements	**#Feature Req**	**69**		**46**		**75**	
	Must-Have	17%		13%		19%	
	Should-Have	48%		41%		31%	
	Could-Have	35%		46%		51%	
	Won't-Have	0%		0%		0%	
	None	19%		78%		9%	
	Coverage	84%		56%		91%	
CP	1	DAOStack		Aragon		MakerDAO	
	2	Aragon		Colony			
DSS Solutions	1	Colony	76%	Colony	94%	Colony	91%
	2	Aragon	72%	Aragon	88%	Aragon	90%
	3	DAOStack	58%	DAOStack	86%	DAOStack	80%
	4			MakerDAO	83%		
	5			Molochdao	48%		
	6			Kleros	37%		

The DSS scored DAO Stack as the third solution, and only it supports "delegable voting" as a Should-Have feature. Moreover, "automatic reputation flow" is another Should-Have feature supported by Aragon and DAOStack, respectively, the second and the third solution. because the effect of Could Have features.

The Should-Have features have higher priorities than the Could-Have features, so DAO platforms that support more Should-Have features score higher. However, because the Could-Have features supported by Colony are a lot, the DSS offers Colony as the first solution.

5.2. Case study 2: SecureSECO

The cybersecurity project SecureSECO intends to make the worldwide software ecosystem safer by maintaining a distributed ledger of facts about the software used in the field. The data collected and maintained in the ledger can prevent vulnerabilities in a software configuration from being abused by malicious attackers.

The SecureSECO project is a collaboration between five companies and five universities with over ten researchers and tool developers who collaboratively contribute to the vision of a safer and more secure worldwide software ecosystem. They perform academic research, participate in hackathons, and provide academic research data for other research groups about software.

The SecureSECO project collectively calculates trust metrics for software packages and software-producing organizations. SecureSECO follows the open-source mantra that if there are enough participants, any software problem can be solved, and it is the community that should be in charge of a trust mechanism. For this reason, decisions about the trust calculation mechanism are taken by the collective instead of a centralized entity. For this reason, SecureSECO is managed in a DAO. In this way, they can provide meta-data on software trustworthiness, similar to the air we breathe and the water we swim in.

5.2.1. Requirements

The experts at SecureSECO defined the following subset of requirements for implementing the DAO (for more details, see Table 6).

- They need a DAO that should endure if some parts (computers, nodes, etc.) are broken (R01).
- The DAO must provide a mechanism by which people can buy tokens, vote, and sell the tokens (R11).
- The DAO must support smart contracts that a set of roles are predefined by computer code in a smart contract, which is replicated and executed by all network nodes, and it should be upgradeable (R77, R03, and R20).
- They need a DAO to configure and update its governance system (R14).
- The popularity in the market (R63), scalability (R06), maturity level (R62), and upgradability (R55) are the main quality concerns of the experts at SecureSECO when they want to select potential DAO.
- The potential DAO should be mature enough and trendy in the market because they have comprehensive documentation and friendly communities (R05, R17).

5.2.2. Results

The case study participants at SecureSECO identified 46 DAO feature requirements. Based on their assumptions, they prioritized over 50% of them as soft constraint (Could-Have and Should-Have) features. The SecureSECO experts indicated *Aragon* and *Colony* as their top potential DAO platforms.

Table 6 shows that Colony was the first feasible platform for SecureSECO. Aragon, DAOStack, MakerDAO, Molochdao, and Kleros were scored as the second to sixth potential solutions. They only identified a small number of Must-Have features and defined a limited number of Must-Have features. They identified Could-Have features more than others. Thus, the DSS had to suggest more feasible solutions.

5.3. Case study 3: Aratoo

Aratoo is an Iranian decentralized autonomous organization that aims to liberate the Iranian cryptocurrency market. They are developing, amongst other products, a DeFi wallet for managing cryptocurrencies. A DeFi crypto wallet is a non-custodial wallet where the users have complete access and control of their private keys and funds. DeFi wallets are at the core of the concept of "be your own bank".

Aratoo is a transparent platform that uses smart contracts and native protocols to reduce investment risk, increase profits, and expand blockchain technology and decentralized systems. They have employed DeFi ecosystems, such as MakerDAO and CurveDAO, for lending, borrowing, exchanging, and governing.

The DAO will allow liquidity providers to decide on adding new pools, changing pool parameters, adding token incentives, and many other protocol aspects. A pool is a smart contract that implements the StableSwap invariant, thereby exchanging two or more tokens.

A DeFi wallet primarily allows users to store their funds without relying on a third party. The DAO is essential for the Aratoo because people can trust the government to update feeds promptly and accurately make changes across the DeFi ecosystem. In other words, DAO's role is protocol governance and value accrual. There need to be strong incentives for the people involved in the DAO to report accurate updates, vote on them, and maintain that reporting/voting behavior into perpetuity. Aratoo needs a DAO to govern and control the Voting App's protocol admin functionality and implementation.

5.3.1. Requirements

The experts at this company indicated the following subset of requirements of their DAO (for more details, see Table 5).

- They need a DAO that a single individual or organization does not control (R08).
- They need a mechanism that investigates the grid resources' trustworthiness through a reputation system and then decides the results (R12).
- The DAO must support that proposers receive an automatic reputation reward if their proposal passes (R30).
- The DAO must provide a feature to manage its collective object databases and maintain their curation (R24).
- The DAO must provide a feature that can set a rate at which a DAO's token is minted and a ceiling to the supply (R25).
- They need an analytic dashboard that shows real-time system feedback (R28).
- Scalability and upgradability of the DAO were two key quality concerns of the case study participants (R06, R07).

5.3.2. Results

The case study participants at Aratoo identified 75 DAO feature requirements, including 19% hard-constraint features (Must-Have) and 82% soft-constraint features (Should-Have and Could-Have).

The case study participants looked for a platform supporting "token distribution" (R04) and "lazy consensus" (R35) as two Should-Have features. Based on our assessment, Aragon, Colony, and DAOStack support both of these features. "Revenue sharing" (R57) as a Should-Have feature is not supported by Aragon.

The DSS suggested many infeasible solutions; hence we had to relax part of the hard constraints (Must-Have and Won't-Have features) and convert them into soft constraints (Should-Have and Could-Have). For instance, the case study participants identified the "intellectual property" feature as Must-Have feature. However, we had to convert it into a

Should-Have feature as a soft constraint. Moreover, case study participants identified the "membership management" feature as a Won't-Have feature, and we converted it into None (without prioritization).

6. Analysis of the results

The DSS suggests that *Colony*, *Aragon*, and *DAOStack* can be feasible solutions for all three case studies (see Table 6), which means that these DAO platforms support all of the features with *Must-have* priority for these case studies. It makes sense as these DAO platforms are in the top-5 list of popular solutions in the market (see Table 2); moreover, their maturity levels are relatively high, as they support most of the DAO features that we have considered in this study (see Tables 3 and 4).

Scalability and upgradability of the DAO platforms were two key quality concerns of the case study participants (see Table 5), so they considered at least one of the top-5 DAO platforms as their potential solutions. Table 6 represents that the DSS can come up with more feasible DAO platforms than human experts (for instance, SecureSECO case study).

Table 5 shows that supporting Infrastructure decentralization, On-chain, Upgradeable contract, Token-based voting, Transparency portal, Funds allocation, Scalability, Upgradability, Reputation-based voting, Governance upgrade, Extensibility, Permissionless, Shared Resource, and Proposals were DAO features that all of the case studies assigned priorities to and defined as their DAO feature requirements. All of the case study participants somehow declared that the upgradeable smart contract is essential as it allows us to iteratively add new features to our DAO or fix any bugs that may be found in production.

It is not surprising that infrastructure decentralization and on-chain governance were prioritized as two essential features for all case studies, as these two features are crucial in a DAO. One of the case study participants mentioned that with using infrastructure decentralization, there is no single point of failure; every department has the internal infrastructure to handle, analyze and manage data. Thus they are not reliant on a single central server to handle all the processes.

Another case study participant about on-chain governance mentioned that the main advantage of on-chain governance is the codification of rules that govern the entire network and can be known by all participants in the network. Also, they mentioned that on-chain governance has several benefits over its informal counterpart, including a decentralized decision-making process, binding code changes, transparency, quicker consensus, and fewer malicious hard forks.

Table 6 shows that the case study participants who confidently indicated the feature requirement were advised a limited set of alternative solutions. Hence, the higher number of hard-constrained feature requirements (Must-Have) on unique programming language features leads to fewer alternative solutions.

For instance, dOrg prioritized their feature requirements according to their current main solutions (DAOStack and Aragon), so they have assigned Must-Have priority to particular features, such as supporting infrastructure decentralization and reputation-based voting. In other words, their feature requirements were biased to the features that their shortlist of DAO platforms supported them with.

The results show that flexibility in the feature requirements leads to more alternative solutions. For instance, the DSS suggested a broader list of alternative solutions to the case study participants at *SecureSECO* as they did not emphasize particular feature requirements and defined more soft-constrained (Should-Have and Could-Have) features.

The case study participants confirmed the DSS solutions. However, experts from dOrg mentioned that Colony is one of the best solutions, though the lack of reputation/token-weighted voting would be a significant issue. Also, they mentioned that Aragon and DAOStack (the second and third solutions) are on the Mainnet network, so we are faced with some problems such as high gas fees, disincentivizing participation, and operational challenges moving funds back and forth from a side-chain.

7. Discussion

The validity metric is defined as the degree to which an artifact works correctly. There are two ways to measure validity: (1) the results of the DSS compared to the predefined case-study participant shortlist of potentially feasible DAO platforms, and (2) according to the domain experts' opinion.

7.1. Case studies

We conducted a set of interviews with the experts at three case study organizations and asked them to indicate their feature requirements based on the MoSCoW prioritization technique. If the DSS suggests infeasible solutions, we need to relax part of the hard constraints (Must-Have and Won't-Have features) and convert them into soft constraints (Should-Have and Could-Have). If the DSS did not suggest any feasible solutions, we would use this technique to relax some of the feature requirements.

Henceforth, we have ranked the feature requirements based on the number of DAO platforms that they support. We can identify the features that lead to infeasible solutions if they are prioritized as Must-Have or Won't-Have. Then, we changed the most vulnerable features from Must-Have to Should-Have or Won't-Have to None (without priorities). We have done it iteratively until we find at least one feasible solution (see Table 5).

7.2. Expert interviews

We did not use formal coding to analyze the interviews and the literature. What we did do, however, could be termed incremental concept development. During the literature study and interviews, concepts were identified that were relevant. Candidate qualities and features were identified, defined, and fine-tuned with the interviewees and later confirmed by asking the interviewees for a post-analysis of the interview and literature results. While this did not constitute formal coding, we did mark concepts related to the domain, came up with the literature study, and came up with the interviews. Secondly, these concepts were incrementally fine-tuned until the interviewees reached an agreement.

One of the experts asserted that smart contracts define a decentralized autonomous organization. However, a good organization also needs liquid funds. It needs to make good decisions and communicate in all instances. There is no management within a DAO, only decision-making capabilities executed by a code distributed across thousands of computers. Hence, smart contracts play an essential role in the DAO.

The experts expressed that technical vulnerabilities of DAOs include cybersecurity, voting procedure, and voter manipulation. They mentioned that the immutable nature of blockchain ledgers could also make the DAO vulnerable to attacks because it is so difficult to alter the essential construction of the DAO if a bug in the code appears. So almost all of the experts mentioned that it is crucial to consider security requirements in selecting a DAO platform.

7.3. The decision model

The case study participants confirm that the updated and validated version of the DSS is helpful and valuable in finding the shortlist of feasible solutions. The case study participants stated that the updated and validated version of the decision model is sound and valuable in finding the shortlist of feasible DAO platforms. Moreover, the DSS reduces the time and cost of the decision-making process. The case study participants expressed that the DSS enabled them to meet more detailed DAO feature requirements. Furthermore, they were surprised to find their primary concerns, especially when different experts' opinions were combined.

The case participants also confirm that the decision model decreases the time and cost of the decision-making process. Our website[8] is up and running to keep the decision support system's knowledge base up-to-date and valid. The supported DAO features are going to change due to technological advances. As such, the decision model must be updated regularly. We envision a community of users of the DSS who maintain and curate the system's knowledge and consider building such a community as future work.

Decision support systems can be employed to make decisions quicker and more efficiently; however, they suffer from adoption problems [75]. A DSS supports rational decision-making by recommending alternative solutions basis the objectivity. Although limited rationality plays a crucial role in decision-making, subjectivity should not be discarded. A DSS promotes objectivity and dismisses subjectivity, drastically affecting the decisions' reliability.

We believe that this study's theoretical contribution and the answer to the main research question (see Section 3.2) are a decision model that can be used to make informed decisions in software production. Models from software engineering, such as the ISO standard quality model and the MoSCoW prioritization technique, are fundamental building blocks in such decisions. Researchers can replace the ISO standard quality model with more specific quality attributes to customize the decision model. Although we employ the MoSCoW prioritization technique to simplify the understanding and manage priorities, other researchers can employ other types of prioritization techniques to define the feature requirements.

Researchers can more rapidly evaluate DAO platforms in the market by using the knowledge available through the decision model, and also they can add more platforms or features to the decision model systematically according to the presented guideline, and employ the reusable knowledge (presented in Tables 2–5) to develop new concepts and solutions for future challenges.

7.4. Limitations and threats to validity

The validity assessment is an essential part of any empirical study. Validity discussions typically involve construct validity, internal validity, external validity and conclusion validity.

Construct validity refers to whether an accurate operational measure or test has been used for the concepts being studied. In literature, decision-making is typically defined as a process or a set of ordered activities concerning stages of problem identifying, data collection, defining alternatives, and selecting a shortlist of alternatives as feasible solutions with the ranked preferences [76,77]. To mitigate the threats to the construct validity, we followed the MCDM theory and the six steps of the decision-making process [30] to build the decision model for the DAO platform selection problem. Moreover, we employed document analysis and expert interviews as two different knowledge acquisition techniques to capture knowledge regarding DAO platforms. The DSS and the decision model have been evaluated through three real-world case studies at three real-world enterprises in the Netherlands, the United States, and Iran.

Internal validity attempts to verify claims about the cause-effect relationships within the context of a study. In other words, it determines whether the study is sound or not. To mitigate the threats to the decision model's internal validity, we define DSS success when it, in part, aligns with the case study participants' shortlist and provides new suggestions that are identified as being of interest to the case study participants. Emphasis on the case study participants' opinion as a measurement instrument is risky, as they may not have sufficient knowledge to make a valid judgment. We counter this risk by conducting more than one case study, assuming that the case study participants are handling their interests and applying the DSS to other problem domains, where we find similar results.

External validity concerns the domain to which the research findings can be generalized. External validity is sometimes used interchangeably with generalizability (feasibility of applying the results to other research settings). We evaluated the decision model in the context of Dutch enterprises. To mitigate the threats to the research's external validity, we captured knowledge from different sources without regional limitations to define the constructs and build the decision model. Accordingly, we hypothesize that the decision model can be generalized to all decentralized companies and organizations that face uncertainty in the DAO platform selection problem.

Another question is whether the framework and the DSS can be applied to other problem domains. The problem domains [5] were selected opportunistically and pragmatically, but we are convinced that there are still many decision problems to which the framework and the DSS can be applied. The categories of problems to which the framework and the DSS can be applied successfully can be summed up as follows: (1) the problem regards a technology decision in system design with long-lasting consequences, (2) there are copious scientific industry and informal knowledge publicly available to software engineers, and (3) the (team of) software engineer(s) is not knowledgeable in the field but very knowledgeable about the system requirements.

Conclusion validity verifies whether the methods of a study, such as the data collection method, can be reproduced with similar results. We captured knowledge systematically from the sources of knowledge following the MCDM framework [78]. The accuracy of the extracted knowledge was guaranteed through the protocols that were developed to define the knowledge extraction strategy and format (see Appendix A). A review protocol was proposed and applied by multiple research assistants, including bachelor and master students, to mitigate the threats to the research's conclusion validity. By following the framework and the protocols, we kept consistency in the knowledge extraction process and checked whether the acquired knowledge addresses the research questions. Moreover, we crosschecked the captured knowledge to assess the quality of the results, and we had at least two assistants extracting data independently.

8. Related work

In this study, Snowballing was applied as the primary method to investigate the existing literature regarding techniques that address the DAO platform selection problem. Table 7 summarizes a subset of selected studies that discuss the problem. As aforementioned, the last column (*Cov.*) of Table 7 indicates the percentage of the coverage of the considered criteria within the selected studies. On average, 79.24% of those criteria are already considered in this study. In other words, the decision model contains a significant number of criteria, including features and quality attributes, mentioned in the literature.

8.1. Benchmarking and statistical analysis

Some studies employed benchmarking and statistical analysis to evaluate and compare a collection of DAO platforms against each other in the literature. For instance, Valiente et al. [3] performed an analytical comparison of three DAO software frameworks: Aragon, DAOstack and Colony. They focused on their current functionalities for building DAOs and presented a case study using the Aragon framework. They performed the case study of a sample DAO that supports researchers participating in a typical project to manage the different tasks they have to carry out.

Liu et al. reviewed the most recent research activities on academic and engineering scenarios, including governance problems and solutions, typical DAO technologies and related areas. They performed such an overview by identifying and classifying the most valuable proposals and perspectives related to the combination of DAO and blockchain technologies [61]. It relates to our work. However, their work covers ignore quality criteria, while our work considers many of them in the selection

[8] https://dss-mcdm.com.

Table 7
Comparison of a subset of selected studies from the literature that addresses the DAO platform selection problem. The first two columns indicate the selected study (Study) and the publication year (Year). The next column (MCDM) denotes whether the corresponding decision-making technique is an MCDM approach. The fourth and fifth columns determine the type of quality attributes (Quality Attribute (QA)) and the data collection type (Data Col.) of the corresponding selected studies, respectively. The sixth column (Approach) indicates the decision-making approach employed by the studies to address the DAO platform selection problem. The seventh and eighth columns indicate the research methods (R. Method) (including Expert Interview, Document Analysis, Design Science and Case Study) and publication type (including Research Paper, Dissertation, Chapter and Report) of the corresponding selected studies, respectively. The ninth, tenth, eleventh and twelfth columns (#F and #QA and #C and #A) signify the number of features and quality attributes and criteria and alternatives considered in the selected studies. The following three columns indicate the numbers of features (#CF), common quality attributes (#CQA) and alternatives (#CA) of this study (the first row) with the selected studies. The last column (Cov.) shows the percentage of the coverage of the considered criteria (quality attributes and features).

Study	Year	MCDM	QA	Data Col.	Approach	R. Method	Publication type	#F	#QA	#C	#A	#CF	#CQA	#CA	Cov.
Our study	2021	Yes	ISO/IEC 25010 Ext. ISO/IEC 9126	Mixed	DSS	Case study Expert interview Document analysis	Research paper	82	46	128	28	82	46	28	100%
[3]	2020	No	Domain specific	Qualitative	Benchmarking	Case study	Research paper	9	2	11	3	8	2	3	91%
[61]	2020	No	Domain specific	Qualitative	Benchmarking	Document analysis	Research paper	4	0	4	3	4	0	3	100%
[62]	2020	Yes	Domain specific	Mixed	Analytic Hierarchy Process(AHP) Analytic Network Process (ANP) Nominal Group Technique (NGT)	Document analysis Expert interview	Research paper	4	2	6	3	4	2	1	100%
[63]	2020	No	Domain specific	Qualitative	Benchmarking	Document analysis	Research paper	13	5	18	1	12	4	0	89%
[64]	2020	No	Domain specific	Quantitative	Benchmarking	Document analysis	Research paper	6	0	6	6	6	0	2	100%
[65]	2020	No	Domain specific	Quantitative	Statistical analysis	Document analysis	Research paper	4	1	4	4	4	1	4	25%
[17]	2019	No	Domain specific	Qualitative	Benchmarking	Expert interview	Research paper	3	0	3	1	2	0	0	67%
[22]	2018	No	Domain specific	Quantitative	Statistical analysis	Document analysis	Research paper	7	0	7	4	1	0	4	14%
[66]	2018	No	Domain specific	Qualitative	Benchmarking	Document analysis	Research paper	9	0	9	1	2	0	1	22%
[25]	2017	No	Domain specific	Qualitative	Benchmarking	Document analysis Case study	Research paper	9	0	9	3	8	0	3	89%
[67]	2018	Yes	Domain specific	Mixed	Fuzzy logic	Document analysis	Dissertation	9	4	13	9	5	3	0	62%
[68]	2017	No	Domain specific	Qualitative	Benchmarking	Document analysis Grounded theory	Chapter	2	0	2	1	2	0	1	100%
[69]	2020	No	Domain specific	Qualitative	Benchmarking	Document analysis	Report	2	0	2	8	2	0	2	100%
[21]	2020	No	Domain specific	Qualitative	Benchmarking	Document analysis	Report	8	0	8	9	8	0	8	100%
[70]	2020	No	Domain specific	Qualitative	Benchmarking	Document analysis	Report	9	0	9	8	5	0	4	56%
[71]	2020	No	Domain specific	Qualitative	Benchmarking	Document analysis	Report	7	0	7	3	7	0	10	100%
[72]	2019	No	Domain specific	Qualitative	Benchmarking	Document analysis	Report	24	0	24	6	24	0	6	100%
[73]	2019	No	Domain specific	Qualitative	Benchmarking	Document analysis	Report	8	0	8	1	5	0	1	63%
[74]	2019	No	Domain specific	Qualitative	Benchmarking	Document analysis	Report	3	0	3	4	2	0	4	67%

problem.

Ziolkowski et al. [79] explored multiple case studies consisting of three famous DAOs—Aragon, Tezos, and DFINITY. This study introduced each case by depicting the DAOs' organizational and technological structure and brought forward concepts. Second, They have created an understanding of how these days are governed by examining their governance systems in terms of applied/envisioned coordination, control, and incentive mechanisms. Our work could be considered more comprehensive as they studied fewer DAO features and DAO platforms. They studied only three DAO platforms and four DAO features against our study, which considers 82 DAO features and 28 DAO platforms.

Faqir et al. [22] introduced the concept of DAO and reviewed the primary software platforms that offer DAO creation as a service, which simplifies the use of DAOs to non-blockchain experts, namely: Aragon, DAOstack, DAOhaus, and Colony. These platforms were compared by showing their key features. Finally, the authors reviewed the available visualization tools for DAOs. They introduced their open-source tool to plot DAOs' activity and analyze it. While their evaluation is relevant, it also does not cover as many details and features as we do in this study.

Studies based on benchmarking and statistical analysis are typically time-consuming approaches. They mainly apply to a limited set of alternatives and criteria, requiring a thorough knowledge of DAO platforms and concepts. Decision-making based on such analysis can be challenging as decision-makers cannot simultaneously assess all their requirements and preferences, especially when the number of requirements and alternatives is significantly high. Furthermore, benchmarking and statistical analysis are likely to become outdated soon and should be kept up to date continuously, which is labor-intensive.

8.2. MCDM approaches

Selecting the best-fitting DAO platform is a decision-making process that evaluates several alternatives and criteria. The selected DAO platform should address the concerns and priorities of the decision-makers. Conversely to MCDM approaches, studies based on benchmarking and statistical analysis principally offer generic results and comparisons and do not consider individual decision-maker's needs and preferences.

The tools and techniques based on MCDM are mathematical decision models aggregating criteria, points of view, or features [80]. Support is a fundamental concept in MCDM, indicating that decision models are not developed following a process where the decision maker's role is passive [27]. Alternatively, an iterative process is applied to analyze decision-makers' priorities and describe them consistently in a suitable decision model. This iterative and interactive modeling procedure forms the underlying principle of the decision support tendency of MCDM, and it is one of the main distinguishing characteristics of the MCDM as opposed to statistical and optimization decision-making approaches [81].

A variety of MCDM approaches have been introduced by researchers recently. A subset of selected MCDM methods are presented as follows. The Analytic Hierarchy Process (AHP) is a structured and well-known method for organizing and analyzing MCDM problems based on mathematics and psychology. The Analytic Network Process (ANP) is structured on the same basis as AHP; however, it differs from AHP in two ways. (1) ANP does not assume that the alternatives and criteria are independent. The feedback mechanism handles their potential dependencies. (2) ANP has a network structure that forms subnetworks and submodels. The Nominal Group Technique (NGT) is a group decision-making process including problem identification, solution generation and decision-making.

Lee and Park [62] examined the decision-making process and tools applicable to a decentralized autonomous organization. This paper studied a decision-making process that features iteration, visualization, and applicability to DAO with six steps in total and a decision-making tool based on this paper's process. Traditional methods such as AHP, ANP, and NGT have been studied in this paper.

Fuzzy logic is an approach to computing based on degrees of truth rather than the usual Boolean logic. Valiente et al. [25] considered a set of DAO platforms to find the right case study option. They performed fuzzy logic in their analysis as a tool for decision-making. Additionally, the authors explained the conceptualization of DAOs and the defining features of coordination mechanisms within DAOs.

The majority of the MCDM techniques in the literature define domain-specific quality attributes to evaluate the alternatives. Such studies are mainly appropriate for specific case studies. Furthermore, the results of MCDM approaches are valid for a specified period; therefore, such studies will be outdated by DAO platform advances. Note that, in our proposal, this is also a challenge, and we proposed a solution for keeping the knowledge base up to date in Section 7.

8.3. Strengths and liabilities of the decision model

Determining the best DAO platform for an organization is a decision-making process that involves evaluating various alternatives and criteria. Hence, the selected platform should address the concerns and priorities of the decision-makers. Studies based on 'benchmarking' and 'statistical analysis', in contrast to MCDM techniques, primarily provide general results and comparisons and do not consider individual decision-maker's requirements and preferences. Benchmarking and statistical analysis methods are often time-consuming and only apply to limited alternatives and criteria. Furthermore, they are likely to become obsolete quickly and must be maintained up to date regularly, which is a costly operation.

Researchers have presented a range of MCDM approaches in the literature. Most MCDM approaches establish domain-specific quality attributes to evaluate the alternatives. Some approaches, such as Fuzzy and AHP, are not scalable; the evaluation process must be performed if the list of alternatives or criteria is changed. Accordingly, these approaches are expensive and only apply to a limited set of criteria and alternatives.

This study has considered 82 criteria and 28 alternatives for the DAO platform selection problem to build a decision model. The MCDM approach is evolvable and expandable and divides the decision-making process into four maintainable phases.

In contrast to the methods mentioned above, the cost of creating, evaluating, and applying the proposed decision model is not penalized exponentially by the number of criteria and alternatives. Additionally, we introduced several parameters to estimate the values of non-Boolean criteria, such as the maturity level and market popularity of the DAO platforms. The proposed decision model addresses the essential aspects of knowledge management, such as knowledge capture, sharing, and maintenance. Furthermore, it uses the ISO/IEC 25010 [47] as a standard set of quality attributes. This quality standard is a domain-independent software quality model and provides reference points by defining a top-down standard quality model for software systems.

Recently, we have built six decision models based on the framework, such as model-driven development platform selection [44]. These case studies were conducted to evaluate the DSS effectiveness and usefulness in addressing MCDM problems. The results confirmed that the DSS performed well in solving the mentioned problems in software production. We believe that the framework can be employed as a guideline to build decision models for MCDM problems in software production.

9. Conclusions and future work

In this study, the DAO platform selection process is modeled as a multi-criteria decision-making problem that evaluates a set of alternatives and considers a set of decision criteria [82]. Moreover, we presented a decision model for the DAO platform selection problem based on the technology selection framework [5]. The approach provides knowledge about DAO platforms to support uninformed decision-makers while contributing a sound decision model to knowledgeable decision-makers. To develop the decision model, the framework incorporates deeply embedded requirement engineering concepts (such as the ISO software quality standards and the MoSCoW prioritization technique) to create the decision model.

The scientific contributions of this work are threefold. (1) The systematic collection of features from a multitude of resources supports researchers who need a comprehensive overview of DAOs and their features. (2) We prove that the MCDM approach and its supporting decision support system are valuable in new contexts for technology selection. (3) We show that case studies are an excellent research method for evaluating designed artifacts, such as the MCDM framework.

We conducted three industry case studies to evaluate the decision model's usefulness and effectiveness in addressing the decision problem. While organizations are typically tied to particular ecosystems by extraneous factors, however, they can benefit significantly from our DSS by evaluating their decisions, exploring more potential alternative solutions and analyzing an extensive list of features.

The case studies show that the DAO platform decision model also provides a foundation for future work on MCDM problems. We intend to establish the best method for voting in DAOs and study how open-source projects can best be managed/governed using DAOs. For instance, in our future research, we aim to improve the DAO decision context by designing a decision model of voting mechanisms to support organizations selecting a voting mechanism.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

An Expert Interview Protocol

[Evaluation of the DAO features and platforms]

Step 1- A brief description of the project, the decision model, the DSS, and the main goal of the interview.

Step 2- Introductory questions:

- *What do you understand about DAO?*
- *Which features of DAO do you familiar with?*
- *Which DAO platforms are you familiar with?*
- *How long have you worked on DAO platforms?*

Step 3- Decision-making questions:

- *Why do you need a DAO for your company?*
- *How does a decentralized organization typically select DAO platforms?*
- *What are the essential features from your perspective for selecting the best fitting DAO platform?*
- *Which DAO platforms are typically considered as alternative solutions by decentralized organizations?*

Step 4- Evaluation of the sets of DAO platforms/features:

- *What do you think about these DAO platforms/features?*
- *Which DAO platforms/features should be excluded from the list?*
- *Which DAO platforms/features should be added to the list?*

Step 5- Closing

- *What do you think about our work?*
- *May we contact you if we have any further questions?*
- *Can we use the name of your company in the scientific paper, or do you prefer an anonymous name?*
- *Can we use your name in the scientific paper, or do you prefer an anonymous name?*
- *Do you have any questions?*

[Mapping between the DAO features and the quality attributes]

Step 1- A brief description of the project, the decision model, the DSS, and the main goal of the interview.

Step 2- Introductory questions:

- *What do you understand about DAO?*
- *Which features of DAO do you familiar with?*
- *Are you familiar with the ISO/IEC quality models?*

Step 3- Mapping between the DAO features and the quality attributes (note that this step will be repeated for all of the features and quality attributes):

- *Does the DAO feature [X] have a positive impact on the quality attribute [Y]? For instance, if a DAO platform supports Conviction Voting, it means that it has positive impacts on Functional appropriateness and Stability.*

Step 4- Closing

- *What do you think about our work?*
- *May we contact you if we have any further questions?*
- *Can we use your company's name in the scientific paper, or do you prefer an anonymous name?*
- *Can we use your name in the scientific paper, or do you prefer an anonymous name?*
- *Do you have any questions?*

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