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A Taxonomy for the Formation of Enterprise Blockchain Consortia

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Abstract: Blockchain governance is a pivotal subject of interest in both academic research and practical applications, particularly for companies endeavoring to establish and maintain successful blockchain consortia. Despite its significance, the dearth of comprehensive guidance poses challenges for companies striving to build and manage blockchain networks while incorporating diverse influences from various governance theories. This paper addresses this gap by presenting a taxonomy that offers a fully encompassing overview of the multifaceted aspects surrounding the establishment of enterprise blockchain consortia. To achieve this objective, we conducted a systematic literature review to identify pertinent themes and insights related to blockchain governance. Subsequently, the findings were further enriched through in-depth interviews with experts entrenched in the blockchain ecosystem. Lastly, the resulting taxonomy was subject to validation through a comprehensive survey. The taxonomy goes beyond the predominantly technical-focused discussions of blockchain governance and extends them to encompass the broader dimensions of administrative, organizational, economic and legal perspectives. By incorporating these multifaceted dimensions, our taxonomy aims to provide a holistic understanding of the intricate governance considerations inherent in forming and managing sustainable blockchain consortia in enterprise settings. We expect our contribution to serve as a valuable resource for companies aiming to navigate the complexities of blockchain governance and foster the success of their consortium endeavors.

Keywords: Blockchain governance, Enterprise consortia, Systematic literature review, Taxonomy development, Blockchain governance taxonomy, Blockchain governance dimensions, Blockchain governance topics.

1. Introduction

Blockchain technology and its associated programmed protocols (e.g., smart contracts) offer innovative opportunities to businesses, public institutions and other organizations [1]. As collaboration becomes increasingly important to supply chain sustainability and performance [2], blockchain can become a trusted and transparent business process incubator [2, 3]. Blockchain technology can help to overcome these hurdles through securing and distributing data decentralized,

without the need for a central authority to be involved [4–6]. However, blockchain and its industrial applications are still relatively young research fields. Especially when it comes to a purposive and sustainable implementation in enterprise networks, blockchain is still facing various challenges [5]. These challenges are not limited to individual business areas, but rather represent a transformation of processes affecting all areas of the company. In terms of collaboration, companies often have a lack of trust and are afraid of losing competitive and innovative advantages by sharing data [7]. Consequently, one main hurdle for industrial blockchain consortia is that a new form of collaboration is enforced [8], switching from a 'single-business paradigm' to a 'network-based paradigm′.

By setting up such networks, existing power relations have to be carefully considered and mapped [9]. The power relations, or, to be more precise, the balance of the participants' power in the blockchain network, is a complexity-inducing factor. A proper setting has to be found to enable cooperation between the participants; this setting is subsumed under the term 'governance'. Only a limited number of theoretical or empirical contributions have previously been made to the study of governance within a blockchain solution [10]. Thus, deciding on the proper application of governance mechanisms in practice displays another major hurdle [1, 11].

A valid blockchain governance not only manages the power relations properly, but also puts multiple factors like the identification of the appropriate legal entity or the financial controlling of the network into consideration. The overall goal of blockchain consortia is a sustainable, functional and beneficial cooperation, which is influenced by many aspects. To establish a governance structure in a blockchain consortium therefore is a complex and multi-factorial task, considering different needs of the individual, connecting it to the vision and goals of the whole network and with permanent respect to the individual entities and the given boundary conditions.

Nevertheless, in the scientific literature there is no consistent definition of the term 'blockchain governance', which leads to a lack of a common understanding of tasks, aspects and attributes that need to be considered in the context of a governance structure [12]. This is mainly due to the fact that blockchain governance combines various elements of several governance theories of other domains, and in the individual scientific sources, each has its own definition depending on the respective background of the researchers [13].

In this paper, we use the definition of Laatikainen et al. (2021): "Blockchain governance encompasses technical and social means to make decisions [...] related to [...] business, technological, legal, and regulatory aspects of a blockchain system during its whole lifecycle" [13, p. 73]. The authors list several focus dimensions (such as the economic and legal perspective), while they include corporate, IT, internet, platform and open-source governance perspectives [13]. By having such a multi-layered view on different governance areas, this definition sets itself apart from other efforts to define blockchain governance.

Although blockchain technology promises increased value propositions, the ability of the blockchain technology to evolve is currently often limited by network or blockchain governance issues that need to be resolved first [14]. A comprehensive analysis linking technological and institutional elements is lacking so far [15, 16].

This paper therefore targets the provision of a comprehensive summary of strategic and operational topics and tasks that need to be considered to build a sustainable blockchain consortium in an enterprise context. A task-based perspective has thus far not been adopted. Our goal is to develop a tool that enables networks and their participating companies to decide on a suitable blockchain governance that combines the influences of all aforementioned, relevant governance approaches. To address this gap, we created a taxonomy through a comprehensive review of existing literature, aiming to encompass all relevant factors involved in the development of blockchain governance [17]. Following that, the taxonomy has undergone various iterations through semi-structured interviews with experts, and was finally validated through a survey. As a result, the final version of the taxonomy consists of five dimensions: administration, organizational, economical, technical and legal, which were identified during the process. With this tool in hands, we want to establish a framework which can be used to set up vision-driven, operational, sustainable and long-living blockchain networks by answering the following two research questions:

RQ1: Which dimensions have to be considered to form a holistic blockchain governance approach?

RQ2: Which mandatory tasks can be identified for each dimension?

This paper is structured as follows: Chapter 2 lists essential publications that already focused on blockchain governance. Chapter 3 describes the approach of the applied scientific methods, starting with the systematic literature review from which resulted the foundation of our taxonomy. Then, the process of taxonomy development is explained in detail. The chapter closes with the description of the interview methodology. Chapter 4 presents the taxonomy as a whole and describes the key findings, e.g. the identified topics per dimension. The taxonomy itself is presented in the form of a morphological box for intuitive understanding of potential users, and because a morphological box enables structuring knowledge on the basis of categories and assigned elements. A discussion of the results follows in Chapter 5, taking into account the survey-based evaluation results, before this paper concludes with an outlook in Chapter 6.

2. Related Work

Several research studies have been conducted to explore and analyze various aspects of blockchain governance. This chapter presents a review of relevant literature that contributes to the understanding and elaboration of blockchain governance frameworks and models.

A widely known blockchain-based framework for blockchain governance has been presented by Van Pelt et al. (2021), consisting of six governance dimensions (formation and context, roles, incentives, membership, communication and decision-making) [18]. The taxonomy therefore mainly focuses on management aspects among the network participants, whereas the taxonomy developed here also includes technical, economic and legal aspects.

Laatikainen et al. (2021) conducted a literature search, reviewing 75 articles related to blockchain governance [13]. As a result of the review, they developed a dynamic model to better grasp blockchain governance. The elaborated model is meant to be used as a reference framework for further analyzing and developing the governance of blockchain systems [13]. A few smaller restrictions of this framework, which have to be examined in more detail in the future, are, that a more in-depth description of the conceptual model and its several building blocks would be valuable and an implementation of the dynamic model within a practice-oriented environment for its validation is required.

The International Organization for Standardization (ISO) (2022) published a quasi-standard in 2022, titled 'Blockchain and distributed ledger technologies − Guidelines for governance' [19]. This guideline offers a framework for fulfilling governance requirements in blockchain systems, including considerations of risks in a regulatory context. The ISO standard focuses on the technical aspects and also introduces a role model and legal requirements. What is missing here are aspects of stakeholder management between different participants and external stakeholders. [19]

Ziolkowski et al. (2020) conducted an exploratory multiple-case study on decentralized autonomous organizations (DAOs) [20]. Their research aimed to understand stakeholder interests, incentive mechanisms, control and coordination mechanisms, technical considerations, and the influence of off-chain instances on blockchain governance. This case study analysis thus offers a good insight into the decision-making problems that can arise in a blockchain network, but leaves out other hurdles such as economic aspects.

In another study by Ziolkowski et al. (2019), the focus was set on governance in blockchain systems [16]. The research proclaimed six key governance decisions, derived from 15 blockchain systems across four application domains. The study focused on the governance mechanisms and decision-making processes within blockchain systems. As in the previously mentioned publication by Ziolkowski et al. (2020), in this publication again the six key decision were in the spotlight of analysis [20]. Questions regarding data authenticity or property division are placed in the foreground, but several other important questions like the identification of the appropriate incentive mechanism or how to handle internal collaboration are not considered either.

The aforementioned studies provide valuable insights and frameworks for analyzing, understanding and developing blockchain governance. They offer perspectives on dimensions, dynamics, guidelines, and case studies related to governance in blockchain systems. These contributions form a foundation for the subsequent analysis and development of a governance framework. But although each mentioned publication delivers precious contributions, the findings are partly fragmented and focus on different as well as individual aspects of blockchain governance. While each work is emphasizing one specific or some subcategories of blockchain governance, they do not provide a holistic approach to build sustainable blockchain consortia or networks in an industrial context. Our work differs from the publications presented in this chapter in such way that a taxonomy is developed, which is as comprehensive as possible and can be used in a wide variety of use cases, while previous work has focused more on specific applications or individual dimensions.

3. Methodology

To develop such a holistic approach to support and enable the formation of sustainable enterprise blockchain consortia, we first identified relevant aspects of blockchain governance through a systematic literature review and elaborated a first draft of our blockchain governance taxonomy [17]. Subsequently, we refined the initial findings with semi-structured interviews, whereby the taxonomy, its categories and characteristics were gradually adapted and optimized in the development process. In the end, we validated the final iteration of the taxonomy through a questionnaire.

3.1. Systematic Literature Review

To start off, a systematic literature review has been conducted. The process was carried out in accordance to the methodical approach of vom Brocke et al. (2009, 2015) [21, 22]. For this purpose, the four literature databases ScienceDirect, SpringerLink, Scopus, and AIS eLibrary were used to identify suitable literature. The use of multiple databases allows the avoidance of platform bias and to extend the scope of potential findings [23]. The following search string, narrowing the search results to correspondences in title, abstract and keywords, focuses on a general linkage of the both relevant topics blockchain and governance:

TITLE-ABS-KEY (Blockchain AND Governance)

No further search parameters, such as the publication date of the source, were applied to get an unbiased pool of results and to guarantee the holistic perspective of our approach. The only applicable restrictions were the accessibility of the papers and the exclusion of sources written in languages other than German or English; these were not considered due to language barriers. The selected databases already guarantee that the identified papers have a certain degree of quality, as most of them are peer-reviewed and published in conference proceedings, journals or books. We then systematically narrowed down the result set until only meaningful publications were left in the result set. The process can be seen in Fig. 1 and is explained below.

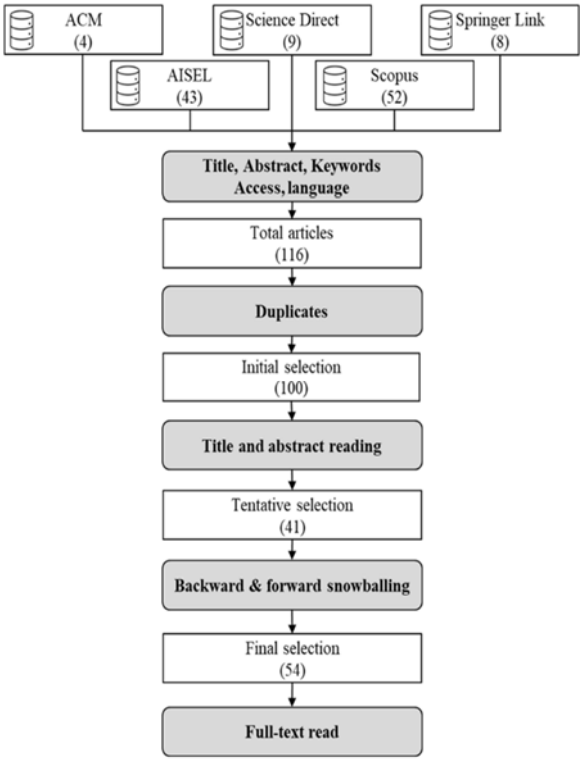

Fig. 1. Process of the systematic literature review.

The search resulted in 116 hits, which confined to 100 results after removing duplicates. An abstract screening was performed, comparing the given keywords and titles with the abstracts to identify fitting publications. Finally, the scientific contributions that included aspects for the development and implementation of a holistic blockchain governance approach were drawn into further consideration and resulted in 41 relevant publications. By performing a backward and forward search to identify publications that have previously fallen through the search string grid, the initial results were supplemented by additional findings [23, 24]. Through this, a further 29 papers have been identified, of which 13 papers have been incorporated into the taxonomy development after content analysis. In total, 54 papers serve as a basis for the further analysis.

3.2 Taxonomy Development

To structure the results in a comprehensive way that also allowed clustering and hierarchical structure of the derived topics, we chose to create a taxonomy. A taxonomy is a classification scheme that groups entities based on their overall similarity, starting from elementary similarities and progressing to broader categories, allowing for comparison and contrast at multiple levels [25]. To build the taxonomy in a rigorous way, the development process following Nickerson et al. (2013), adapted by Kundisch et al. (2021), was carried out [26, 27]. The methodology describes the development of taxonomies as illustrated in Fig. 2 and is already established in the information system domain.

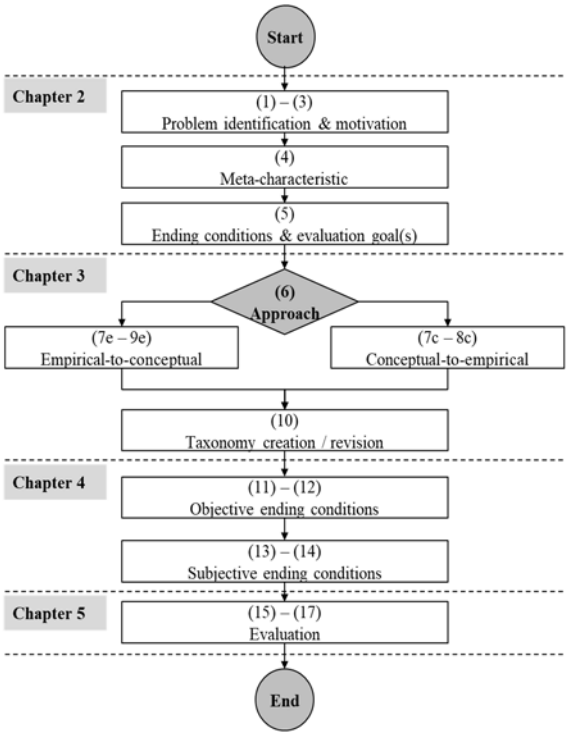

Fig. 2. Taxonomy development process following Nickerson et al. (2013) and Kundisch et al. (2021) [26, 27].

The process starts with the *identification of a problem* (1) [27]. Many enterprise networks are interested in using blockchain solutions in their business operations and want to participate in blockchain-based networks. However, during the integration processes the companies repeatedly face the challenge of bringing the developed blockchain components into use [28]. A crucial factor to bring a blockchain network of collaborating companies to its full potential often were failures due to questions regarding the organization of the network and other governance aspects (e.g. data sharing, ownership issues). Literature research could not provide a satisfactory approach as an answer to this challenge. The fact that companies currently face difficulties setting up joint blockchain networks and organizing

the collaboration is the motivation to development our taxonomy.

Directly derived from the observed problem, the initial *target group* (2) consists of members of our research project that faced the exact challenge of building blockchain consortia due to governance uncertainties [27]. These were mainly enterprises investigating the blockchain technology in the logistics domain. Enterprise networks consist of companies that form value chains with an underlying tier-based structure [29]. We quickly found out that the aspect of developing a sound governance structure requires a combined approach, considering the technology itself on the one hand, but also taking the already existing formal and informal structures of collaboration into account. In this respect, we broadened our scope and focused on the development of a holistic approach to form suitable and sustainable blockchain enterprise consortia by developing sound governance structures. Therefore, further restrictions (e.g. regarding a concrete or special industry) were not made. Rather, the focus is any enterprise blockchain consortium. Blockchain networks whose primary purpose is the trading of a cryptocurrency are thus explicitly excluded and do not belong to the target group of the taxonomy to be developed.

Following this, it is now necessary to state the *purpose* pursued with the creation of the taxonomy (3) [27]. As described, companies currently do not know which topics represent hurdles in the establishment of a blockchain network and need to be answered within the consortium. Since a literature search did not uncover any corresponding tools, the aim is to develop our own taxonomy to support companies when setting up a blockchain network by presenting relevant topics in a comprehensive manner. In turn, this overview is meant to serve as a starting point for governance development, while it can be combined with adequate methods and tools for addressing all identified topics. In addition, it shall be suitable for governance changes, also ensuring sustainability of the consortium in the medium to long term future.

Next, it is necessary to define a *meta-characteristic* (4) to narrow down potential objects of the taxonomy and thus decide on its content [26, 27]. For the taxonomy described, it is determined that topics are focused that are primarily relevant when setting up a blockchain network. Furthermore, when considering potential topics, the perspective of the entire consortium is taken into account, rather than that of an individual company. Finally, not a specific industry or network type is focused. This is intended to provide an overview of relevant issues that is as holistic as possible and can be applied to various use cases.

The next step is to define the *ending conditions and evaluation criteria* (5) for finishing the taxonomy development process. The ending conditions are necessary to complete the iterative process of taxonomy development. Nickerson et al. (2013) list eight objective and five subjective ending conditions that are adopted for the creation of this taxonomy (see Table 1) [26].

Table 1. Objective and subjective ending conditions following Nickerson et al. (2013) [26].

Objective Ending Conditions
1. All objects or a representative sample of objects have been examined
2. No object was merged with a similar object or split into multiple objects in the last iteration
3. At least one object is classified under every characteristic of every dimension
4. No new dimensions or characteristics were added in the last iteration
5. No dimensions or characteristics were merged or split in the last iteration
6. Every dimension is unique and not repeated
7. Every characteristic is unique within its dimension
8. Each cell (combination of characteristics) is unique and is not repeated
Subjective Ending Conditions
I. Concise
II. Robust
III. Comprehensive
IV. Extendible
V. Explanatory

Kundisch et al. (2021) propose five different evaluation goals for taxonomies: better description, identification, classification, analysis and clustering of objects [27]. In accordance with the research goals stated in chapter 1, the *better identification of relevant topics* during the initiation of enterprise blockchain consortia is mainly chosen as the evaluation goal, while the *better clustering* is the secondary objective.

As suggested, we pursued multiple iterations of taxonomy development (6-10).

We started with an *empirical-to-conceptual* approach, collecting relevant governance topics from the existing governance literature, especially focusing on governance-related tasks. After the initial collection of characteristics through a systematic literature review of essential papers, we consolidated the topics into sub-dimensions and dimensions to get an initial version of the governance taxonomy [17].

Afterwards, we added multiple *conceptual-to-empirical* phases to review and improve the taxonomy, by challenging, extending and altering our initial collection of tasks and dimensions. For example, the legal dimension was extended with two additional topics, while all categories and characteristics were optimized through the sharper assignment of exact tasks and the use of applicable terminology. The conceptual-to-empirical iterations were based on the input from expert interviews (see chapter 3.3) and additional literature.

After each iteration, the *objective* (11-12) and *subjective* (13-14) *ending conditions* (Table 1) were checked to determine whether the development process is finished or has to be continued. The objective ending conditions are reached when no fundamental changes occurred to the overall structure of the taxonomy, its dimensions and characteristics. After fulfilling the objective ending conditions, the subjective ending conditions are applied to the taxonomy, checking the quality of the taxonomy in terms of completeness, comprehensibility, and usability.

In a last step, the final iteration of the taxonomy was *evaluated* (15-17) through a survey. To receive a complete feedback regarding the taxonomy, we evaluated nine criteria (see Table 2). These are aligned with the previously selected, overarching evaluation objectives (better identification and better clustering of relevant topics) and explicitly focus a business-driven perspective. A deeper insight in the results and findings of the evaluation, as well as some recommendations for further improvements, are analyzed and discussed in detail in chapter 5.

Table 2. Evaluation criteria of the blockchain governance taxonomy.

Evaluation Criteria
(1) Overall clarity & comprehensibility
(2) Coverage of all relevant aspects
(3) Logic of all identified topics & dimensions
(4) Usefulness
(5) Clarity in regard to relationships & dependencies between elements
(6) Fit with specific governance needs & objectives
(7) Assumed improvements regarding core processes & overall effectiveness
(8) Usability for practical implementation
(9) Recommendation

3.3. Semi-structured Expert Interviews

The first draft of the taxonomy was literature-based [17]. In later iterations, and in addition to further literature analysis, we refined the taxonomy through expert interviews. For this purpose, a semi-structured questionnaire was prepared and answered in the course of the interviews. Additionally, the first taxonomy draft was provided as a basis for discussion. In conducting the interviews, the five characteristics of interviewing according to Yin (2009) were applied, which enable an open and adaptable structure in the course of the conversation [30]. The key findings were entered directly on an interactive digital collaboration tool, where a version of the taxonomy was presented and explained by the interviewers. Notes were taken during the interviews and subsequently submitted to the interviewees for approval. A total of ten expert interviews were conducted, which were scheduled to be sixty minutes long. In particular, the interviews focused on the impression regarding the completeness, understanding and meaningfulness of the entire taxonomy, as well as the individual topics [31]. Table 3 shows the experts' role, subject area, and years of expertise and experience in the field of blockchain technology.

Table 3. Overview – expertise of the interview partners.

Role	Subject Area	Years of Expertise	Code
Lead Developer	Blockchin development	5+	E01
Lead Developer	Blockchain development	5+	E02
Blockchain expert & researcher	Blockchain technology	3+	E03
Blockchain expert & researcher	Blockchain business models	3+	E04
Blockchain expert & researcher	Blockchain business models	3+	E05
Researcher	Blockchain business models	1+	E06
Lead Developer	Blockchain development	5+	E07
Blockchain expert & researcher	Blockchain governance	3+	E08
Senior Blockchain expert	Blockchain business models	5+	E09
Blockchain expert & researcher	Blockchain governance & sustainability	3+	E10

In the following chapter, the final version of the developed blockchain governance taxonomy (Table 4) is presented, focusing especially on the results.

4. Results

Following the steps indicated by Kundisch et al. (2021) 20 topics were iteratively identified for the five dimensions and are presented in Table 4 as a morphological box [27]. In this chapter, the individual topics are explained in more detail to provide an insight into each headlined task. To this point, there is no hierarchy between the dimensions or within the tasks. Also, no specific sequence is implied through the arrangement of the tasks. We chose to arrange the tasks alphabetically, as interdependencies or chronology have to be researched in further iterations. Nevertheless, on a qualitative level there are of course some dependencies between the topics within a dimension and cross-dimensional, which are covered in the following description texts of each dimension and their allocated topics.

Table 4. Blockchain governance taxonomy.

Dimension	**Topics**			
Administration	Decision-Making	Purpose & Vision	Risk Management	Roles & Responsibilities
Organizational	Internal Collaboration	Processes	Stakeholder Management	Terms & Conditions
Economical	Business Model	Financial Controlling	Incentive Mechanisms	Investment & Funding
Technical	Provision & Supervision	Blockchain Framework	Data Management	Development
Legal	Audit & Control	Compliance	Legal Entity	Regulatory Requirements

4.1. Administration Dimension

The *Administration dimension* represents the foundation of the overall network structure, including the four strategy-related topics 'Decision-Making', 'Purpose & Vision', 'Risk Management' and 'Roles & Responsibilities'.

The first topic, *'Decision-Making'*, covers all tasks that have to do with strategic decisions and the process of finding consent within the blockchain consortium. By this we do not only mean to technically establish consensus between nodes on transactions; decision-making also lays emphasis on the superordinate task to enable the network to reach agreement on governance tasks. To do so, a well-designed coordination mechanism has to be in place to achieve consensus among the network participants [1, 4], considering different types and levels of decisions [3]. They include both determinations *in* the network (process-oriented, e.g. consensus, transaction withdrawal or override and forking) and decisions *about* the network (network-oriented, e.g. further development, adaption of the vision …) [5]. Decision-making is highly relevant in the context of enterprise consortia insofar as determinations have to be made between independent entities that are pursuing different or contradictory goals [5]. Finding consent is not any longer a single enterprise's task, but becomes a network task, which has to be handled in a more collaborative way [15, 32]. It is important that choices are made which are advantageous for the whole consortium [33]. To do so, the process of finding agreements and its underlying legislation (e.g. how are decisions made, under which conditions are decisions accepted, what counts as a majority, who is allowed to participate and vote, … [1, 6, 28]) has to be carefully designed. Relevant information has to be collected and passed to the deciding entities [3].

At the same time, conflict management poses major problems for many networks within consensus-oriented communities, since a way is required that prevents paralyzing blockades and divisive conflicts between network participants [34, 35]. There are multiple sources of conflicts. For example, Ziolkowski & Schwabe (2021) identify four main conflicts between network participants, resulting from competition, information asymmetries, regulation and private reasons [36]. Ways have to be found to solve conflicts.

Finally, decision-making has to cover and contain change management aspects, taking into account that technology itself, but also the socio-economic and legal environment can evolve. To cover all phases of a it system's lifecycle and to provide a sustainable network, blockchain governance systems need to evolve to survive [12].

The second topic, *'Purpose & Vision'*, displays a particularly important role in the long-term success of a blockchain consortium [34]. It is crucial that all stakeholders pursue a common goal, not only focusing on a few powerful partners, in order to sustainably benefit from such a project and to evoke investment and commitment [34, 37, 38]. The central change is that former independent organizations now decide on a common future [39]. Besides a future-oriented vision which establishes long-term development and long-time investment, a sound and meaningful purpose of the blockchain technology needs to be identified to guarantee an ongoing fit between network goals and blockchain-based network tasks on a high level [18]. There are several reasons to build or join a consortium, four motives are exemplary pointed out by Ziolkowski et al. (2021) [28]. In addition, Zavolokina et al. (2020) identify two types of blockchain consortia, one being business-oriented (solving business problems) and the other one being technology-oriented (develop infrastructure to be used in different contexts) [5]. The development of a vision and the identification of meaningful purposes may also lead to first implications for further analysis, such as the designated degree of (de)centralization [3, 40, 41] or the needed balance of openness and closure [42]. Already in the development phase of a prototype, the creation of a common vision is indispensable, since communication channels are often not established at the beginning and there is often a lack of experience in collaboration, which is why the central goals must be clear to all participants [5, 28]. Here, in addition to economic sustainability, environmental and social aspects are also of interest and need to be clarified, as different blockchain characteristics also have different effects on the three dimensions of sustainability – economic, ecological and social [42].

Another topic that needs to be thoughtfully designed as part of governance is the implementation of functional *'Risk Management'* and risk mitigation strategies [19, 43] covering internal risks as well as arising risk resulting from the socio-economic and legal environment [28]. The objective is to minimize risk exposure and severity. Blockchain systems embed democratic principles and trust into network settings, reducing common network risk, but also introduce their own technological security risks. For example, it must be ensured that the network cannot be hijacked by a single party. In classic blockchain systems, the majority limit plays an essential role, the network should therefore needs to be protected against a single party holding 51% of all validating nodes [19, 44]. Further responses to unforeseen events have to be implemented, such as forking or the handling of bugs and other code errors [45, 46]. The risk of single-point-of-failure outages can be reduced by increasing the number of network participants, which is dependent on the chosen blockchain framework and accessibility settings). Risks may arise from different sources, e.g. the collaboration with others and even competitors, regulatory aspects such as data protection, the current status of reputation of the blockchain technology and hype, changes in the consortium and others [5, 28]. Here, a comprehensive risk security level is aimed for, which analyzes and minimizes both classic physical and classic digital as well as newly introduced network- and blockchain-based risks. Accordingly, the initial threat and risk analysis must be carried out before the blockchain network is implemented off-chain for the first time. While the system is in operation, it must also be possible to evaluate risks (and opportunities) and react flexibly to changes from within and without the network (e.g. change of the participants, regulation …) [1, 37].

For appropriate consideration of all internal actors, roles with associated rights and responsibilities have to be defined that are directly connected to tasks, duties and liabilities. This is covered in the *'Roles & Responsibilities'* topic.

So far, there is no agreement on which roles have to be implemented, and which entity typically has to fill which role. This is highly individual and depends on the specific context and design of the blockchain system. Additionally, there can be necessities to arrange the role setup in hierarchies [16, 18] or with respect to other interdependencies; any interfaces between roles then have to be considered in the course of the role definition process.

For example, use case-specific roles are sometimes taken into account in addition to the technological ones [5]. Then, there can be made a terminological distinction between two kinds of roles: the functional roles and the IT roles. The functional roles (e.g. users, validators, miners, token holders …) operate within the blockchain network and make use of the technology in the context of their business processes, while the IT roles (e.g. developer, maintainer, host …) comprise those network participants that enable, extend and operate the network technically. While the distinction of those roles can be easily done by their individual task, it is likely that both role types can be applied multiple times, while one network participant can hold more than one role at a time [45]. Some roles and the extent of their amount of rights can be dependent on the level of integrity, as full-node operators and light-node operators may hold different rights [1, 14]. There can be additional thoughts, e.g. if new members own other rights than established ones, and it has to be defined which participation rights are given to new members [47]. The decision-rights managing structure therefore also has a huge impact on the participants' authority. There is an extensive list of possible roles [1, 14, 48], from which the relevant have to be identified and utilized for the own consortium; it is also possible that novel roles have to be defined, or that sub-roles with sub-sets of rights and responsibilities have to be established to fit the own consortiums' needs and requirements.

In accordance with the chosen framework, roles in a blockchain network are first and foremost associated with the rights to access, read, write and validate the data. In terms of governance, there are also other considerable dimensions (e.g. asset control rights, co-determination in further developments …) [13].

An important set of rights that are directly linked to the decision-making process, are voting or decision rights. It enables participation in the decision-making process and determines the level of power one entity holds in the network [49]. These rights are paraphrased as "who has the authority and responsibility to do what" [50, p. 2] in a system. Taking into account the context, it has to be clarified if decision-making rights are placed "on individual actors', formal organization, or on consortia's level" [16, p. 3]. On the other hand, the right to control decisions, meaning ratification and enforcing accountability, has to be distributed [9, 15] to establish controlling instances and to create a system of checks and balances. The distribution of decision and control rights also dictate the level of (de)centralization, limiting the decision-power to just a few or spreading it equally among all participants [15], and defines the distribution of authority [40].

Later, the derived roles have to be implemented on-chain and anchored in the technical framework and its fundamental protocols. When the roles are implemented, procedures and criteria have to be established that allow allocation of roles to the network participants and actors [42].

4.2. Organizational Dimension

The second dimension, *Organizational*, includes the topics 'Internal Collaboration', 'Processes', 'Stakeholder Management' and 'Terms & Conditions'. It is distinct from the previous Administration dimension, as both cover different levels of activities: while the Administration is focused on strategic management of the blockchain-based network consortium, the Organizational dimension covers tactical and operative tasks.

The first topic *'Internal Collaboration'* involves setting up interdisciplinary teams, establishing communication channels, and defining an appropriate level of transparency. Here, the heterogeneity, the spatial distribution and the different attitudes and experience levels of the participants must be adequately taken into account [5]. In the initial setup phase of such a network, the development of functional interdisciplinary teams is crucial for the success of the project, as transitioning to such a novel network structure requires addressing challenges from various domains such as technical expertise and economic understanding [5, 45]. In addition, blockchain governance must provide and establish appropriate communication among participants [18, 19, Interview E10]. In this case, communication can occur off-chain through traditional IT systems or on-chain directly via the blockchain [13, 18]. This could include, for example, the introduction of a network board [5]. Last but not least the possibility for identification (versus anonymity) of participants is specific and should be considered according to the requirements of each blockchain project [51]. Regardless of the grade of identification of participants, they or their systemically created representations should be continuously monitored by on-chain implemented algorithms to prevent malicious behavior by individuals or collectives and protect the integrity of the organization [52].

The objective of the second topic is to identify the useful functions and determine the necessary *'Processes'* [49], including the core blockchain-based business processes as well as the relevant supporting processes. The core functions in the context of a blockchain network are those (inter-organizational) business processes in which blockchain technology can leverage potential and which should be handled via the network. Therefore, the relevant processes have to be translated into blockchain-based transactions, with according and sound data blocks, a meaningful use of consensus and blockchain functionalities (e.g. smart contracts, token). Support processes are those processes which on the one hand enable the business or core processes (e.g. data provision) and on the other hand are in any other mean relevant to maintain the network functionality. Here, the translation of all necessities regarding decision-making, conflict resolution, risk management, role allocation etc. is conducted [53], based on the decision from the Administration dimension.

The network users have a distinctive role in the success or failure of the blockchain network, which is why *'Stakeholder Management'* is essential for the success of the blockchain network [53]. The aim is to identify the internal actors and external stakeholders, and to subsequently manage the membership of the former and the external relationships to the latter.

Membership management includes assigning roles to the participants in terms of their activities in the network, and the distribution of according tasks. When interested entities, groups or parties want to join (or when members want to leave) the network, it is also task of the stakeholder / membership management to define procedures and rules for the on- and off-boarding [1, 50].

External relationship management portrays the connection to all entities that surround the system but are not an inherent part of it and exist beyond its borders [34, 54]. Because the blockchain network is itself a system, and additionally part of bigger systems (socio-economic, legal etc.), the external world has to be assessed regularly [37, 51]. Even public relations, information campaigns and news, improving recognition and attraction, can be part of the work of external relations [55].

So far, there is no consensus in the literature on which persons or entities belong to the network participants and which typical roles they assume. This is highly individual and depends on the context and design of the blockchain system. For example, use-case-specific roles are sometimes considered in addition to the technology-specific ones (e.g., insurance companies, repair shops, sellers, and buyers [53]), while Matsuo & Ushida (2021) identified four general stakeholders who are relevant for each blockchain network (regulators, developers, business entities, consumers) [56]. There are also interdependencies between Stakeholder Management and the selected network type: in the context of public blockchains, everyone can operate a node and join or leave the network self-determined, while private or consortial blockchains appoint or select node operators carefully [1].

The last topic is the implementation of *'Terms and Conditions'*. In particular, the definition of access requirements for a network as well as exit scenarios must be specified [Interview E09]. Especially in the development of a new blockchain consortium, the definition of access requirements is also strongly linked to other issues such as the process of decision-making [13]. Further, agreements, policies, codes of conducts, guidelines, standards and other forms of formalities have to be established, outlining accepted actions, defining forbidden or unwanted behavior, describing control and coordination mechanisms and presenting consequences for the latter [12, 57, 58]. In this aspects, the topic is to some extend related to the legal dimension, especially in correspondence to the compliance task (see chapter 4.5). Those internal regulations do not necessarily have to be written down in form of a contract, but can also be directly implemented into the code [31]. Nevertheless, as governance is developing dynamically and constantly, not everything can be implemented on-chain [45]. Therefore, additional agreement formats such as contracts can be created to govern the off-chain share of the network consortium.

4.3. Economical Dimension

The establishment and operation of blockchain-based networks necessitate a differentiated view on economic factors, because costs and revenues need to

be equitable distributed among network participants, making the *Economical dimension* pivotal in establishing the economic relations among all actors within the network [5, 8, Interview E09]. Accordingly, the economic dimension of blockchain governance is dedicated to those tasks that regulate the economic relations of the cooperation of all actors within the blockchain network. The dimension can be divided into four aspects, namely the derivation of a proper 'Business Model', the establishment of 'Financial Controlling' of incoming and outgoing value streams, the choice of a fitting 'Incentive Mechanism' concept, and the management of 'investment & Funding'.

The first topic *'Business Model'* is of great importance when establishing a blockchain consortium, primarily due to the challenges in measuring the derived benefits across multiple companies [59, 60]. In existing consortia, it is also necessary to demonstrate the extent to which blockchain technology will enhance the organization's business model [61]. Blockchain technology not only enables improvements for the existing business processes, but it can also generate further added value and new revenue streams [62]. The chosen business model defines where value emerges and is therefore of huge interest to all participants.

The implementation of blockchain solutions involves the active participation of numerous stakeholders from diverse functions within each participating organization, including purchasing, sales, and supply chain management, among others [63]. As a result, thoughtful consideration becomes crucial to enable well-informed financial decisions and foster the development of sustainable blockchain-based business models [18]. In the realm of blockchain systems, where actors collaboratively co-create value, it becomes imperative to address the critical question of how to ensure a fair and equitable distribution of this value among all participants [13]. The success and longevity of the consortium heavily rely on the establishment of a business model that effectively balances the capture, creation, and context of value, ensuring a harmonious fit between these key elements [13, 28]. Additionally, it poses a major hurdle for entities to join a blockchain network when they do not clearly see or understand possible benefits [53]. Likewise, costs have to be made transparent in the beginning [36], so that every participant can approximate its cost-benefit ratio, although not all benefits are quantifiable. By achieving dynamic stability through a well-aligned business model, the consortium can create an environment conducive to shared success and continuous value generation. It is most likely that new business models arise, rooting in existing ones that are built around classic centralized and intermediated structures, and developing towards multilateralism and more equal distribution of power between network participants [61].

The implementation of '*Financial Controlling'* in a blockchain governance consortium is directly linked to the aforementioned business model; while the business model describes the overall concept, including sources of added value and the overall distribution of costs and benefits among all participating parties, the financial controlling means the operationalization of these plans, and is strongly related to their supervision and enforcement. The necessity of proper financial supervision arises from the need to address the identified challenges and costs inherent in the governance concept [10, 64], considering all stages of development and lifecycle and the corresponding cash flows and cost structures and covering aspects such as initiation, integration and system maintenance [5]. By conducting rigorous financial controlling practices, the incurred costs within the consortium can be meticulously tracked and managed. This systematic approach allows for a comprehensive assessment of resource allocation, cost-efficiency, and financial transparency [10]. Additionally, financial controlling ensures that the financial aspects of the blockchain governance are aligned with the overall objectives and strategic vision of the consortium [5].

Furthermore, financial controlling provides the basis for making informed investment decisions. Relying on the financial transparency and the collection of finance-related indicators within the financial controlling and by having a clear understanding of the financial aspects and potential returns, network participants can confidently assess the viability of investments and allocate resources optimally [37]. This approach fosters a sound financial foundation, supports efficient resource management, and ultimately contributes to the long-term success and viability of the blockchain governance consortium [36, 37].

Particularly under the premise that such a network will function successfully in the long term and that more parties may become interested in participating in it, it is crucial to identify and develop a suitable *'Incentive Mechanism'* concept [12, 34], involving both monetary and non-monetary rewards [51]. The incentive mechanism will effectively allocate costs and benefits, thereby proactively preventing conflicts from arising and facilitating cross-company collaboration and investments. [18]. The design of these incentives obviously affects the motivation and actions of the actors. Effective incentives are instrumental in promoting desired behaviors within the system and fostering the achievement of common goals [13]. Properly aligning incentives for organizations and users is critical to successful consortium governance, as it ensures that all stakeholders are motivated to act in a manner that benefits the collective interests of the network [65].

Incentives within a blockchain network can take various forms, both pecuniary and non-pecuniary, as the system offers a diverse range of values to its participants, such as specific privileges, enhanced reputation, or increased visibility [15, 66]. A vital aspect of incentive mechanisms is their role in coordinating actions among different groups within the consortium. Since it is improbable that all entities will have totally aligned interests at all times, the

ability of each consortium to coordinate around their common goals becomes crucial in driving positive change [12]. Uneven coordination among groups can lead to power imbalances favoring certain entities within the network [12].

Finally, a clear *'Investment & Funding'* strategy must be defined. Otherwise it can lead to major risks and challenges not only for the initial installation but especially for the expansion of a consortium [37]. The financing of the venture can be facilitated both privately, for example by individual investors, and publicly, such as through crowdfunding. With private funding, there is often a centralized structure where a few individuals set the strategy. This in turn has implications for network participation, transparency, etc. [40]. Last but not least, returning make-or-buy decisions will have to be made to determine whether the blockchain infrastructure should be updated software- and hardware-like, run on a new platform or be managed by a third party [1, 67].

4.4. Technical Dimension

The *Technical dimension* focuses on the central technical conditions and prerequisites. As blockchain itself is a technology, such topics are considered here that technically enable blockchain-based cooperation and collaboration between all actors their consortium. Both software and hardware aspects have to considered [52, 68]. As central topics of the technical dimension, 'Provision & Supervision', the identification of a suitable 'Blockchain Framework', a proper 'Data Management' and further 'Development' can be identified.

The first topic *'Provision and Supervision'* contains the definition of the required hardware and software resources to get the network running in the beginning, and to assure that the technical infrastructure operates reliable ever on, including back-up strategies and maintenance routines [49]. Therefore, permanent maintenance and functional guarantee is necessary for ongoing operation [14]. Consideration should also be given to automated messages and alters when maintenance intervals are due or when an increase in resources is required to implement a lasting maintenance strategy. For this purpose, monitoring of central key performance indicators would be useful [13].

Multiple factors and demands have to be considered, and in addition to the pure computing capacities for operating the blockchain network, the technical needs of the connected parties and the mapped business processes must also be satisfied [16]. In addition, it makes sense to provide necessary interfaces to enterprise software or oracles at an early stage so that data can flow between the systems. Interoperability must also be considered at the level of the hardware and software systems as well as in terms of user interoperability in the context of governance [69]. In a next step, the connection of and interoperability between different blockchain systems may also become relevant [51].

Focusing on the hardware and software in any current state they are in, it is necessary to eliminate minor and major flaws to guarantee high standards of (technical) safety and operation; it is therefore mandatory to constantly review components and code. Connected to overall incentives, bug bounty programs can be established to motivate all participants to discover and report bugs [54]. This is distinct from any further development of the technical components, which is subsumed in its own topic.

The second topic deals with the identification of a suitable *'Blockchain Framework'*. Since central decisions on the network structure have already been made in the course of the organizational and administrative considerations, and a conceptualization of fitting incentive mechanisms was conducted in the economical dimension, a first step in the context of the technical aspects is the translation of those requirements into blockchain properties. The selection of a suitable framework that can implement the central governance aspects is therefore a critical part of the governance and blockchain development process.

Technical aspects of blockchain technology like peer-to-peer networking are such fundamental that they are undisputed. Some properties can be chosen from several options due to internal and external demands, like the specific consensus algorithm which displays a "keystone of the entire blockchain technology" [68, p. 3]. Furthermore, the specific design of the blocks (e.g. size) has to be specified [41]. Overall, multiple factors have to considered, such as the possible transaction throughput, storage capacity, software architecture, security, scalability, velocity etc. [10]. Further settings regarding the technical solutions are whether the network is built public, private or consortial, and if transaction participation is permissioned or permissionless [58, 68].

Some functionalities are not mandatory but very useful to enterprise networks; the need for constructs such as smart contracting, tokenization and decentralized applications [41] has to be carefully evaluated in the process of framework identification and selection, as not all frameworks support all functionalities. For example, there are frameworks that are suitable for high levels of smart contract automation [48].

One further key decision is which data is shared in the network and written to the blockchain, subsumed under the topic *'Data Management'*. Since this strongly controls the amount of data on the blockchain, it is a critical decision with regard to the performance of the overall solution, such as the number of transactions per unit of time or the entire amount of data. If too much data is written on the blockchain, the amount of data increases quickly, so that the resource demands increase rapidly for each owner of a full node. The two aspects of data management – making data available on the one hand and ensuring data quality via the blockchain´s inherent consensus – need to be planned, especially in the focus of inter-organizational data exchange and data storage in the course of this task [53].Therefore, an agreement of

data provision and data usage has to be made by the network participants [70]. There is another crucial factor besides the operational aspects of data management: data security. In an economic context, especially the handling of sensitive data must be clarified in order to provide certainty on how the data is used, and who has access to which information. Data protection is not only of interest for commercial participants, it is also regulated, e.g. by specific data protection legislation [28, Interview E10]. Therefore, it has to be decided which data is stored on the blockchain, and whether it is really written down transparently or merely referenced to a local storage location] [51].

The last topic *'Development'* is significant for the sustainable success of the network. Transparent structures must be built to determine who is responsible for further development and how the direction of further development is decided [Interview E01-02, E06-07]. Especially in the rapidly evolving blockchain universe, the technology used can quickly become obsolete; therefore, it has to be consistently monitored if the market offers new developments [5]. Major changes to the underlying infrastructure, including hardware as well as software, or changes to the code (meaning additions, upgrades, or general development in terms of newer versions) [71] must be given to someone's responsibility, while the management of development has to be defined (reporting, controlling, operation, coordination) [20]. While decisions on changes are made considered within its own task, technological choices are also included [28].

4.5. Legal Dimension

The final dimension of the blockchain governance taxonomy covers the *Legal* aspects that arise from the use of such an interconnected system. Each network is located within a regulatory, normative, political-administrative environment [56, 72], bringing along norms, laws and broader societal influences that ultimately lead to a strictly recognizable regulatory framework which heavily affects the system design. Transferred to a blockchain network, this means that the surrounding legislation has to be taken into account carefully when designing the governance structure. This task is fulfilled in the context of the legal dimension, inheriting those specifications that have to be recognized in accordance to the legal prerequisites and requirements. The continued compliance with the applicable law ensures sustainability of the blockchain network on a permanent basis. The four topics of the legal dimension are 'Audit & Control', 'Compliance', 'Legal Entity' and 'Regulatory Requirements'.

The first topic is the issue of *'Audit & Control'*. It covers all the internal monitoring processes to maintain the operation of the network by continuously ensuring that the mandatory legal requirements within the blockchain governance framework are taken into account in detail and are adhered correctly. To this end, the correct application of, and compliance with, all external laws as well as all internal and external compliance requirements are constantly tracked. If changes are recognized internally or externally, a suitable approach of adoption and transformation is defined to quickly adapt to the new circumstances, and to guarantee steady compliance. Therefore, an ongoing surveillance should take place both during implementation and operation, so that it is possible to react to changes in the framework conditions and to initiate adjustments to the system. If the system is certified, continuous accordance with the certification requirements has to be guaranteed. The existence of blockchain network-internal procedures regarding the detection, assessment, modification and change of existing legislation and regulations, along with the solving of compliance issues, is an essential component for a functioning network system [59]. At the same time, the network must also continue to consider and apply blockchain-independent legislation, regulations or partner agreements [13, 73].

'Compliance', the second topic of the legal dimension, is closely connected to the regulatory requirements topic. The individual observations which have been made there, such as legislation or specific compliance regulations [53], are examined here for their feasibility with the existing blockchain governance framework. The main task covered here is the translation into the internal regulation set, meaning the introduction and implementation of the rules that were identified during the constant surveillance happening in the regulatory requirements task. It is important to consider both external specifications and internal needs of formal and informal character. In the event of identified ambiguities, they have to be subsequently examined in detail and measures have to be established that resolve them sustainably. To do so, it is important that a rigid or flexible concept of use and application is in place [10]. In addition to the existence of legislation, regulations or standards that arise from outside of the blockchain network, blockchain network-internal arrangements between the actors have to be agreed upon and applied. They include rules, procedures and guidelines, for example in the form of (written) documents or in the form of common understandings and shared values [13].

The third topic, and also another crucial factor, is the determination and the definition of the specific *'Legal Entity'* of the individual blockchain network and its participants [13]. Here, several issues such as the clarification of ownership, property rights, accountability, clarification of liability and responsibility between all network participants, as well as the certificate of incorporation of the network, have to be defined and prepared [1, 74]. Ultimately, all this must be known by every network participant directly from the beginning [Interview E03-07, E09].

As blockchain technology is still highly novel, not all possible legal aspects are already discussed and covered in own legislation. An example from German law is that when technology emerges further, it is

likely that not humans but software (such as artificial intelligence) interacts via smart contracts. Here, it has to be clarified what legal relationships arise when the contracting parties are no longer humans but machines. Thus far, under German law *automated* decisions made by software are attributed to the user. If an *autonomously* issued declaration of intent is to be assumed, a direct assignment to the user is not possible without restrictions. Then, for example, a software agent acts as a contracting party, whose legal status is not yet finally clarified in German law according to widespread opinion. There are some discussions regarding the introduction of an e-person to deal with those kind of situations [75].

The topic *'Regulatory Requirements'* comprises all activities which are related to the identification of applicable specifications and regulations as well as all the obligatory legal requirements and legislations regarding the blockchain governance framework [5, 28]. The task acts as a sensor for the legally determining outside world as well as the internal needs of the network. Consequently, blockchain governance fundamentally includes decisions based on and in accordance with laws, regulations, company policies, standards and agreements [13, 64]. In addition to the initial analysis of the applicable normative texts and legal sources, a constant comparison with the legal-regulatory influences must also take place during implementation and ongoing operation, so that it is possible to react to changes in the framework conditions, and to arrange an adjustment of the system [19]. Thus, only the legally compliant operation of the network leads to legally compliant transactions between the participants of the network. For this, conformity with laws and regulations, but also with regard to common social standards, conditions and agreements, must be ensured [76].

As the regulatory requirements topic displays the surveillance task, identifying all applicable requirements from the inside as well as from the outside, the compliance topic means the translation into rules that are included into the governance structure. While the former discovers potential influences, the latter tries to inherit them into the existing body of blockchain governance. The audit and control task rounds of the legal trinity by applying control and correction mechanisms to ensure and maintain legal accordance.

5. Discussion

After deriving the taxonomy, its dimensions and characteristics (topics), the last step was the evaluation of the final iteration. To do so, we conducted an online survey, asking the participants to anonymously answer twelve questions. We contacted twenty experts via email, who were selected carefully for their experience with blockchain projects, especially in an industrial or enterprise context. We asked both participants of the interviews as well as completely new experts. On the one hand, we wanted to receive a feedback on our progression from earlier stages of the taxonomy, and on the other hand we aimed for new and unbiased feedback. We received ten feedbacks, the response quote therefore corresponds to 50.0%, which forms the basis of the subsequent evaluation and discussion.

The evaluation purpose was to identify if the taxonomy offers a holistic identification of relevant topics that are related to blockchain governance in enterprise consortia, and if the topics are clustered in a meaningful and useful way.

The first nine questions of the survey were designed to answer both described evaluation purposes. The participants were asked to rate nine specific attributes[1] (see Table 2) on a Likert scale [77], which is standard in survey questionnaires, with 1 meaning the lowest grade of consent and 5 meaning the highest-possible level of agreement. The last three questions were open text questions, collecting recommendations for further improvements.

The applied Likert scale is ordinal scaled. That means, values have an internal order, but the distance between two options is not equally [78]. The survey results were evaluated with adequate statistical methods and are visualized with applicable diagrams [79]. Fig. 3 shows the relative distribution of the selected attributes per criterion, while Fig. 4 presents the results in corresponding boxplots. Outliers are marked when the data point is outside of the 1.5 times interquartile range, either below the first quartile or above the third quartile.

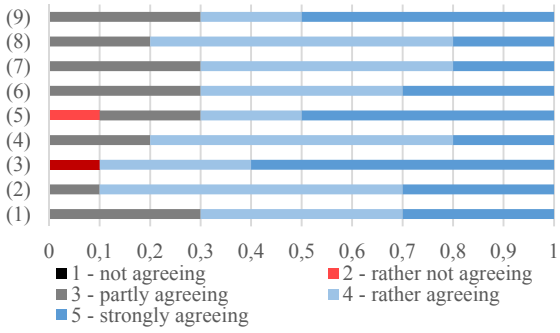

Fig. 3. Evaluation results, visualized as a stacked bar chart.

In total, the blockchain governance taxonomy received proficient evaluation results, with the medians ranging from 4 (rather agreeing) to 5 (strongly agreeing). For all criteria except (3), logic of dimensions and topics, and (5), clarity in regard to

[1] (1) Overall clarity & comprehensibility, (2) Coverage of all relevant aspects, (3) Logic of all identified topics & dimensions, (4) Usefulness, (5) Clarity in regard to relationships & dependencies between elements, (6) Fit with specific governance needs & objectives, (7) Assumed improvements regarding core processes & overall effectiveness, (8) Usability for practical implementation, (9) Recommendation.

relationships and dependencies between elements, the answers ranged from 3 (partly agreeing) to 5 (strongly agreeing), representing an overall strong assessment of the corresponding criteria. On the other hand, especially criterion (2), coverage of all relevant aspects, and criterion (3), logic of all identified topics and dimensions, received outstanding positive ratings, so that these specific aspects were already perceived as very good by the respondents in the final state of the taxonomy. Interestingly, criterion (3) is additionally the only one that owns an outlier, being rated with 1 (not agreeing); it is therefore considered significantly different from the rest of the data. Criterion (3) is thereby simultaneously the overall best-rated category and the one with the single worst rating.

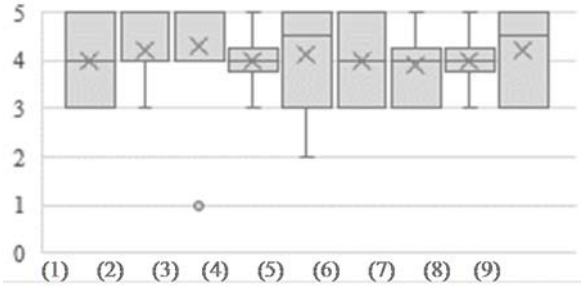

Fig. 4. Evaluation results, visualized as boxplots; criteria are arranged from left (1) to right (9).

Concerning the reviewed criteria (1) overall clarity and comprehensibility, (4) usefulness, (6) fit with specific governance needs and objectives, (7) assumed improvements regarding core processes and overall effectiveness, (8) usability for practical implementation and (9) recommendation, the average rating was 3 (partly agreeing) to 5 (strongly agreeing) with a tendency towards 4 (rather agreeing).

We additionally analyzed the three open text questions to get a better impression of feasible positive and/or negative comments as well as suggestions for enhancement. From this, we gained valuable improvement proposals for future iterations. For example, one participant stated that the focus on human and behavioral aspects (motivation, experience, willingness) is underrepresented. Within our taxonomy, we have located these topics in the category of 'Stakeholder Management'. In addition, the interplay between blockchain and additional technologies was mentioned as further potential. Often, blockchain solutions use IoT devices that generate the data. Within our taxonomy, aspects of interoperability with other technologies are included in the 'Provision & Supervision' topic. The next participant stated that he needs further information to fully grasp the true meaning of all dimensions and topics, while another one hinted that the Administration and Organizational dimensions may overlap to some extent. In contrast, most participants analyzed the taxonomy as comprehensive and precise (1), and the distinction regarding the given elements of the taxonomy as good (5).

With the results presented, we finally got the impression that the presented taxonomy is sound in terms of completeness, and offers a clear and comprehensible overview of tasks and topics related to the establishment of sustainable enterprise blockchain consortia. The participants perceive the taxonomy and its implications as beneficial, and improvements compared with current conditions and aspirations are expected. Additionally, the usability was positively evaluated, enabling good access for practitioners with low entry barriers. On average, the survey participants would rather recommend the taxonomy. Therefore, in accordance with our set evaluation purposes, the assessment points out that the derived blockchain governance taxonomy indeed offers a holistic view on blockchain governance tasks, also considering a meaningful and useful clustering of the items in a practicable way.

6. Outlook, Limitations and Future Research

In the context of this publication, the topic of blockchain governance was examined with a special focus on enterprise blockchain consortia, but not limited to them. A holistic approach was chosen to derive relevant topics, which were finally structured in a taxonomy in the form of a morphological box. By presenting twenty governance-related topics and sorting them into five superordinate dimensions, the taxonomy offers an overview about relevant tasks to set up and operate sustainable enterprise blockchain consortia. Through the application of the taxonomy, companies and other users are supported in dealing with core governance aspects, both clarifying crucial matters in early stages of the network ramp-up and maintaining effectiveness throughout the operation.

Considering the five derived dimensions and their associated topics, it can be recognized that a holistic approach is necessary to develop fully functional blockchain consortia, unleashing their full potential and guaranteeing success in the long-run. Therefore, a careful interaction between administrational and organizational matters, supplemented by economical, technical and legal topics, is essential. The latter are especially relevant as blockchain is still a novel technology that demands participation of all stakeholders in the network and careful consideration of legislation, while economical aspects as costs and value streams have to be defined carefully and shared in a fair way among the involved network participants. Because the technology is quite new, the legal and socio-economic environment has also to be screened attentively, so that all operations and decisions are legally compliant. Considering and evaluating all tasks promises proficient conditions to set-up, use and develop a sustainable network. The chosen structure, featuring the dimensions and topics in the form of a

morphological box, offers an easy access and a decent overview, enabling newcomers as well as experts to use the taxonomy. It also allows the combination with other taxonomies or adjacent models like the Dortmund Management Model which describes how enterprises have to manage adaptation processes in general, or the Blockchain Integration Model [62], which outlines how enterprise networks can integrate blockchain solutions specifically.

While the taxonomy was developed scientifically based on a systematic literature review, and challenged both with researchers and developers via expert interviews and a survey, the elaborated taxonomy has to be tested and demonstrated in a realistic context in the future. The evaluation however hints that the practical use, added value for the users and applicability is likely.

During our engagement with the blockchain governance taxonomy we also noted that distinctions can be made, whether one of the aforementioned topics has to be negotiated and handled outside of the blockchain solution, or if there are possibilities to integrate them directly into the blockchain protocol. The first is called off-chain, the second is named on-chain [3, 20, 42]. Both options, as well as hybrid combinations, offer advantages and disadvantages [41]. While DAOs attempt to transfer every decision into on-chain protocols, enterprise networks in earlier stages might prefer to establish some kind of hybrid solutions, integrating as many tasks as possible on-chain and handling the remaining topics off-chain. It is therefore highly interesting to analyze which topics have the potential to be featured on-chain, as this would imply synergy potentials and efficiency gains [44]. Additionally, the individual topics are described so that it is obvious *what* has to be done to cover a specific aspect of blockchain governance; nevertheless, the taxonomy could be extended by collecting and presenting purposive tools and methods, supporting *how* a topic can be approached. Then the taxonomy could be used as blue print, while each dimension and its associated topics would provide a defined tool box. As mentioned before, there is also a potential to further investigate dependencies between the topics and dimensions to identify if some elements are connected to, or to some extend depended on, other elements. As this is essential for the taxonomy development process, each element is independent and unique, but dependencies are neither excluded nor unrealistic. Finally, the taxonomy was developed with the focus set on the initiation of the formation of a blockchain consortium. During the lifecycle of an established network, changes will appear that impact the blockchain network [28]. Frame conditions, the composition of participants, the legal and socio-economic environment and other internal or external aspects will continually develop, so that adaptions of the blockchain governance is needed. While the elaboration of each topic and the explanations in this paper already give an extensive hint to what has to be focused on, it has to be researched in more detail how accurate different stages of the lifecycle are considered, and if there are variations or changes in governmental topics in different phases.

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