New pathways for international business governance via blockchain-based decentralized autonomous organizations

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Abstract

Purpose: This study explores the innovative governance structures enabled by blockchain-based Decentralized Autonomous Organizations (DAOs) in the context of international business (IB). As non-hierarchical entities managed through collective voting and peer-to-peer interactions, DAOs challenge traditional assumptions of multinational corporation (MNC) governance.

Design/Methods/Approach: We perform a literature review, which combines qualitative content analysis of both academic articles on DAO and whitepapers with quantitative analysis of bibliometrics using VosViewer.

Findings: Our findings highlight DAOs' ability to generate new research questions and offer a foundation for future studies on decentralized governance in international business. Through a bibliometric analysis of 73 articles from Web of Science and qualitative content analysis, we identify four primary research streams in the DAO literature. A deep dive into financial DAOs, or DeFi DAOs, reveals insights into their governance mechanisms and implications for the studies in the field of IB.

Originality/Value: This article advances the field by providing a multilevel analysis of DAOs' potential impact on IB, considering macro (country), meso (MNC/DPE), and micro (multicultural team and individual) levels.

Research Limitations: Research on DAOs is in its early stages, and the practice in international business is nascent. As the regulatory, economic, and technological landscape for DAOs changes, more research will be needed on the governance mechanisms and their sustainability.

Keywords: Decentralized Autonomous Organizations, DAO, Blockchain, Bibliometric Analysis, Smart Contracts, Decentralized Finance, International Business

1. Introduction

The questions of managing imperfect markets through the internalization and/or orchestration of goods, services, knowledge, and capital (Caves, 1971) located in different markets have been at the core of the International Business (IB) research (e.g., Holm, Eriksson & Johanson, 1996; Buckley & Strange, 2015; Hennart & Verbeke, 2022; Rugman & Verbeke, 2003). The market imperfections existing due to high transaction costs, information asymmetries, and barriers to entry foreign markets that make external market transactions inefficient or costly (Hennart & Verbeke, 2022) were suggested to be managed through six different theoretical approaches (Industrial Organization, Transaction Cost, Organizational Capability, Contingency, Business Network, and Institutional theories) (cf., Forsgren, 2017) each of which have implied different form of governance of the multinational corporation (MNC) when designing and implementing its strategies (Šilenskytė & Smale, 2021), but all of them to a degree have assumed the benefit of resource orchestration through the MNC hierarchy, power, network (cf., Forsgren, 2017) and (semi-)centralized control (Stendahl, Schriber & Tippmann, 2021).

However, the arrival of advanced technologies, such as blockchain, Internet-Of-Things, and artificial intelligence among others, have brought significant changes in MNCs' strategies (Strange, Chen, Fleury, 2022), availability of and approaches to orchestrate MNC resources (Banalieva & Dhanaraj, 2019), ways to design technology-enabled MNC business models, such as Digital Platforms and Ecosystems (DPEs) (Stallkamp & Schotter, 2021; Šilenskytė, Butkevičienė, & Bartminas, 2024), and MNC governance approaches (Nambisan & Luo, 2021; Singh, Gaur, & Singh, 2023). In particular, by enabling decentralized, peer-to-peer interactions-based governance, public permissionless blockchain technology has transformed scholarly understanding of firm governance (Lumineau, Wang, & Schilke, 2021; Hsieh & Vergne, 2022; Singh et al., 2023) and contemporary forms of MNCs and their DPEs (Šilenskytė et al., 2024). For example, public permissionless blockchain (further for simplicity referred to as 'blockchain') enabled the existence of techno-socio-economic global entities: "*digital community enterprise* – a virtual, decentralized MNC co-creating and co-sharing value with all DPE users and participants through the trusted technological institution" (Šilenskytė et al., 2024, p. 10).

In this article, we explore these under-researched digital community enterprises in the organizational form known as Decentralized Autonomous Organizations (DAOs) (Singh et al., 2023). DAOs are non-hierarchical organizations that operate and record routine tasks on a public permissionless, blockchain-based, peer-to-peer, cryptographically secure, *public* network. They rely on voluntary contributions from stakeholders to manage, evolve, and operate through a democratic voting process (Hsieh et al., 2018; Hsieh & Vergne, 2022). In other words, DAOs are blockchain-based software programs that incorporate governance and decision-making protocols without relying on traditional hierarchical management and/or internalization and (semi-)centralized orchestration of resources of some kind. Instead, as digital entities with no central authority, control, or power, DAOs function through open-source code and smart contracts, i.e., programmable self-executing codes placed on the blockchain (Bashir, 2017), that facilitate reliable exchanges and seamless coordination between globally distributed stakeholders who democratically decide on DAOs further development and collectively benefit from its growth (Hsieh et al., 2018). DAOs embody a system of incentives, via smart contracts, that ensure ecosystem sustainability and growth (Hsieh & Vergne, 2022).

For example, Bitcoin is often assumed to be the first known DAO, which has transformed our understanding about international transactions, showcasing that blockchain technology can *substitute* international banks and serve as a trustworthy decentralized technology-based financial institution enabling peer-to-peer local and international transactions without borders in a cheaper and more efficient way, and moreover, creating benefits not only for the actively contributing stakeholders in the Bitcoin DAO network (known as 'miners'), but also for the entire network performing the transactions (Hsieh et al., 2018). Other companies, such as Animoca Brands, use blockchain-based DPEs to *supplement* more traditional governance forms with DAO as an additional way to finance and grow their digital business globally among the newly emerging crypto-based market (Šilenskytė et al., 2024). Thus, DAOs have emerged as an alternative innovative mechanism to manage market imperfections and create economic value in various forms of IB operations.

Given the emergence of these radically different DAO-based digital collective MNCs and MNCs that employ DPEs' governed in a decentralized manner to supplement their core business model, we take a critical look at this under-researched phenomenon and systematically explore DAO concept, potential, and implications to the IB research. We begin by defining and

explaining DAOs. We then conduct a literature review that comprises bibliometric analysis of 73 articles from the Web of Science, followed by a qualitative content analysis to extract theoretical perspectives, key insights, and DAO applications. Additionally, we analyze case examples of most observed DAOs, i.e., financial DAOs, entitled as DeFi DAOs, that are to some degree similar to Bitcoin, to provide a deeper understanding of how DAOs may transform the governance and operations of MNCs and their DPEs.

The article contributes to the emerging literature on blockchain-based governance (e.g., Davidson, De Filippi, & Potts, 2018; Lumineau, Wang, Schilke, 2021; Šilenskytė et al., 2024) and DAOs (e.g., Hassan & De Filippi, 2021; Hsieh et al., 2018; Santana & Albareda, 2022; Wang, Ding, et al., 2019) by further detailing the particularities of DAO concept and phenomenon as well as overviewing the emerging themes and insights in the field. But more importantly, the paper provides an IB-related research agenda on DAOs further extending the insightful seminal works by Zalan (2018) and Singh et al. (2023) and going beyond the firm-level aspects raised in the latter paper. As DAOs have vague boundaries and can transform IB operations at the multiple levels of analysis, this paper offers the discussion on multilevel implications of DAOs to IB considering macro (country), meso (MNC/DPE), and micro (multicultural team and individual) issues in the governance of cross-border operations.

We also innovate on the methodology by combining both content and bibliometric analyses of the field of DAOs, as suggested by previous studies (e.g., Alon et al., 2021; Jalal et al., 2021; Bargoni et al., 2023), and content analyzing the whitepapers of the DAOs, which outline the DAO's purpose and organizing principles.

The article is structured as follows: We start by briefly explaining the concept of DAO and then perform a detailed literature review on the topic. Bibliometric and content analysis results are then discussed, structuring them around the four core themes identified within the DAO-related research. Since DAO research currently does not cover IB specific insights, we end the paper with more extensive discussion on how DAO as a phenomenon could help us revisit some of the assumptions and practical considerations within the IB research and practice.

2. Understanding DAOs

Organizations are largely defined by their purpose, to which multiple agents contribute, and social, economic, and legal boundaries that define the organization's scope of activities and contributing agents. Moreover, any form of organizing should be able to solve organizing problems, such as task division and allocation, reward distribution, and information sharing (Puranam, Alexy, & Reitzig, 2014). DAOs, an open-source decentralized organization that orchestrates activities through the pre-programmed blockchain technology-based mechanism that incentivizes transactions, solve the organizing problems in a unique way that requires deeper investigation.

The DAO is an ultimate form of blockchain-based network (Lumineau et al., 2021). DAOs represent blockchain technology-based organizations that rely on smart contracts to encode organizational rules, decision rights, and incentive structures without hierarchical control (Beck et al., 2018). Smart contracts automate operations according to predefined rules and parameters, enabling decentralization. DAOs also utilize consensus mechanisms to facilitate collective decision-making, along with incentive schemes like internal tokens to align participant interests and fund activities (Wang et al., 2019).

There are a few conceptualizations of DAOs (cf. Wegner, Zuquetto, and Grisi (2024) for the detailed review) and there are multiple examples of DAOs established for a different purpose. The examples of DAOs span from DAOs for financial transactions and operations (e.g., American CryptoFed DAO, Uniswap), DAOs for donations and other deeds (e.g., UkraineDAO), art investments (e.g., Pleasr), legal services (e.g., LexDAO), networking (e.g., Friends with Benefits), to virtual world management (e.g., Decentraland) (Marr, 2022; Santana & Albareda, 2022). Thus, even if DAOs do not necessarily support organizing where issues to be transacted are highly tacit (Lumineau et al., 2021), there are increasingly many ways to codify issues to be transacted and apply these codifications when creating automated algorithms for self-executing management of DAOs.

The self-executing nature of DAOs, because of which human verification or control are not needed, significantly differentiates DAOs from other advanced technology-based, open-source forms of organizing, in which technology reduces the transaction costs but does not always change the organizational form (Puranam et al., 2014). In DAOs, the system, once set, operates

in a rather passive manner as a self-executing mechanism that manages the operations on the network (Zachariadis et al., 2019). Moreover, since DAOs are based on a specific type of blockchain – public permissionless blockchain for which to function a new economic logic, named crypto-economics, is adopted (Šilenskytė et al., 2024), the technology becomes an institutional force that leads to (self-)assigning and verifying transactions in an automatic manner, assigning value to each transaction individually and in regards of the network (Davidson, De Filippi, & Potts, 2018).

This means that while all types of blockchains can reduce transaction costs and diminish the need for contractual and relational governance for explicit transactions (Lumineau et al., 2021), the public permissionless blockchain adopted in DAOs is additionally capable of and needs to monetize, assign, and distribute economic value related to these transactions (Beck et al., 2018; Šilenskytė et al., 2024). The latter removes the free-riding problem (existing in other open-source technology-based forms of organizing (Puranam et al., 2014)), because in DAOs the governance is based on public permission blockchain, and therefore every transaction, in addition to creating public goods, also provides the extrinsic motivation due to potential financial earnings as blockchain-based networks grow. In DAOs, public permissionless blockchain, as an institutional technology, permits democratic, transparent voting by the members in the network (Davidson et al., 2018), resulting in governance where one or several individuals cannot impose force or power on the organization and collective agreement is required. The consensus mechanisms adopted to automatically verify the transactions on a public permissionless blockchain-based network are (almost) impossible to tamper with, which further eliminates agency-related problems (Hsieh et al., 2018).

To this end, proponents argue that DAOs have several unique advantages over conventional organizations, including lower costs, faster decision-making, transparency, and flexibility. Specifically, by automating administrative and governance functions through smart contracts, DAOs can reduce agency costs and intermediation fees (Cumming et. el, 2023). This self-governing structure also enables more rapid adaptation in response to dynamic market conditions (Park et, el, 2023). Additionally, all actions and transactions are recorded immutably on the blockchain ledger for full transparency (Davidson et al., 2018). Together, these features suggest DAOs may play a growing role as decentralized forms of value creation and exchange.

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However, DAOs also face critical challenges related to governance, regulation, and adoption. Given their decentralized nature, achieving coordination and alignment between stakeholders can be difficult in DAOs (Darabseh & Martins, 2022). Tensions persist around reconciling decentralization with accountability, as governance and dispute resolution prove challenging without recourse to hierarchical structures (Hassan & De Filippi, 2021). Questions around security, accountability, and legal status similarly remain unresolved for many jurisdictions. Still nascent, DAO adoption rates continue to be relatively low, indicating barriers around technical literacy, user experience, and institutional legitimacy.

DAOs have generated much interest for their potential to transform governance, reduce costs, and disrupt traditional organizations, even if substantial challenges and open questions remain regarding their treatment as a new form or organization and certifiability of their potential benefits. Thus, there is a need to unpack DAOs' novel characteristics, benefits, limitations, and issues for future research, and we do so by performing more systematic literature analysis on this topic. Particularly in the context of IB, where transactions across borders and their management have been a central problem of organizing, DAOs are likely to offer interesting avenues for business applications and academic research.

3. Methodology of literature review

For the literature review, this study utilizes both bibliometric and content analysis to examine the current state of literature on DAOs, following the best practices in recently published bibliometric papers (Alon et al., 2021; Jalal et al., 2021; Bargoni et al., 2023). Bibliometric analysis allowed us to identify key research streams, and content analysis was conducted to provide a review of the key topics, theoretical approaches, and key insights in each research stream. Data was gathered from Web of Science using keyword searches, such as Decentralized Autonomous Organizations, Blockchain, Smart Contracts and Decentralized Decision-making. We provide further details on this literature review in the subsequent sections.

3.1 Data Collection
The Web of Science (WoS) database was searched to collect relevant articles. This database was used as it is the "gold standard" among academic databases in the social sciences (Alon et al., 2021). Searches were conducted in English-language articles published from 2018 up to

November 27th, 2022, using titles, abstracts, author keywords, and KeyWords Plus. The mentioned time frame was selected as suitable because even if the first DAO is considered to be Bitcoin that emerged in 2009 (Hsieh et al., 2018), conceptually DAOs appeared only in 2011 (Zamani & Giaglis, 2018), the first DAO was launched in 2016 (Kaal, 2020), and Zamani and Giaglis (2018) paper can be considered as the first academic paper to address DAO as a topic directly (Wegner et al., 2024). Table 1 provides details on the keyword searches and the number of articles included in our analysis. We did not set any specific IB-related keywords because the discussion on DAOs is only emerging and is primarily available within the journals in the field of technology, with only a few journals (e.g., *IEEE Transactions on Computational Social Systems, Internet Policy Review*) publishing on DAO repeatedly (Wegner et al., 2024). It was important to remain inclusive for all emerging insights, interpreting their relevance to IB by content analysis rather than through the search engine results. Given the novelty of the phenomenon and research about it, the articles were included if they discussed DAO both directly (as a concept, organizing form, or similar) and indirectly (if they discussed topics of blockchain, smart contracts, or similar with regards to or in the context of DAOs or its governance).

Table 1. Details of Keyword Searches

Keywords and the research strings	No. of articles
"Decentralized Autonomous organization*"	51
"Decentralized Autonomous Organization*" OR ("decentralized decision-making" AND ("blockchain*" OR "block-chain*") AND ("Smart Contract" OR "Smart-Contract*"))	56
"Decentralized Autonomous Organization*" OR ("DAO*" AND ("blockchain*" OR "block-chain*")) OR ("decentralized decision-making" AND ("blockchain*" OR "block-chain*") AND ("Smart Contract" OR "Smart-Contract*"))	73
"Decentralized Autonomous Governance*" OR "Distributed Autonomous Governance*" OR "Distributed Autonomous Organization*" OR "Decentralized Autonomous Organization*" OR (("DAO*" OR "DAG*" OR "DAS*") AND ("blockchain*" OR "block-chain*") AND ("Smart Contract" OR "Smart-Contract*")) OR (("decentralized decision-making" OR ("Business model" OR "Business-model")) AND "auto*" AND ("blockchain*" OR "block-chain*") AND ("Smart Contract" OR "Smart-Contract*"))	88
After Elimination due to irrelevance or limited access	73

Initially, our search returned 51 articles, which we found insufficient for a comprehensive analysis. To address this, we expanded the search criteria to include additional keywords related to decision-making and business models, increasing the number of articles to 88. After a thorough review, we eliminated 15 articles that were irrelevant (i.e., discussed blockchain or smart contracts without DAO or its governance as a context) or inaccessible, resulting in a final sample of 73 articles. Limitations of this process stem primarily from the dataset boundaries. However, supplementary manual searching helped compensate. This process ensured that only the most pertinent studies were included in our analysis.

To align our search more closely with our study's focus, we used specific keywords and employed clustering techniques to categorize the articles meaningfully. Specifically, we used bibliographic coupling with the "Association Strength" method in VosViewer, which revealed three main clusters: "DAOs Governance, Legal, and Socioeconomic Implications," "Fundamentals in Blockchain, Smart Contracts, and DAOs," and "Applications, Security, and Technical Attributes of Blockchain Technology." We followed an iterative methodology suggested in previous articles in bibliometrics to exhaust all the relevant papers and to remove unrelated ones based on readings (Alon et al., 2021; Jalal et al., 2021; Bargoni et al., 2023).

3.2 Analysis Methods

Regarding the *current state of research and themes*, a bibliographic coupling network was constructed in VosViewer, following a similar methodology of Raut et al. (2024), using all 73 articles, with connections weighted by association strength. To systematically determine themes, the largest clusters were examined first, followed by smaller clusters. Within each cluster, content analysis identified common topics addressed. Clusters were labeled according to their predominant theme. Research streams were plotted over time to reveal growth trajectories. In the second stage of cluster content review, it was observed that themes among a few clusters overlap. For example, several clusters included studies on blockchain applications, features, and governance. Thus, overlapping clusters were merged (see Table 3 and Figure 2).

Further, to identify the most *influential works and key topics*, we used Biblioshiny to generate a ranked list of articles by citations per year. The top cited articles were selected for further analysis. Detailed content analysis was conducted on this core set to extract key topics, themes,

and research methodologies to supplement and verify the major themes that we have extracted from inductive grouping performed with the 73 papers. Themes were categorized and synthesized to provide an overview of the seminal concepts and findings that have shaped DAO research and compared with the initial grouping. After that, we arrived to four research streams currently dominant in DAO-related literature.

To further illustrate DAOs and their governance, in the research stream concerning DAO applications with relevance to (international) business, we delved deeper into the most widely available DAO applications – finance service-related DeFi DAOs. Through purposive sampling, we selected the top 10 DeFI DAOs, based on their market capitalization. We used the largest DeFi DAOs for which there is also a history and a whitepaper. A white paper in the context of a DAO is a document that outlines the DAO's purpose, structure, and governance processes. It essentially acts as a blueprint for the DAO, similar to how a white paper functions for a new cryptocurrency or blockchain project, and usually includes the following components: (1) *Vision and Mission*: The white paper explains the DAO's goals and what problem it is trying to solve; (2) *DAOs Structure*: It details how the DAO is organized, including tokenomics (how tokens are distributed and used for voting) and how decisions are made; (3) *Governance Process*: The white paper outlines the procedures for proposing and voting on changes to the DAO's operations. This explains how members participate in decision-making (4) *Team*: Sometimes, DAOs might have a founding team responsible for initial development. The white paper may introduce them.

In essence, a DAO white paper is a critical resource for anyone interested in understanding how the DAO works and how to get involved, which proved to be a highly effective tool when exploring the concept and nature of DAOs (cf. the seminal analysis of DAO single cases, such as by Howell and Potgieter (2021), Reijers et al. (2021), Corballis and Soar (2022)). While the whitepapers are documents that are central to the emerging phenomenon of DAOs, they are often overlooked in current research and used only for providing examples rather than establishing theoretical insights. The content analysis of the whitepapers performing a comparative case analysis of DAOs offers an innovative approach to conducting the literature review and goes beyond bibliometrics to analyze the content and develop a framework to analyze. In summary, a mix of bibliometric analysis, using VosViewer, and qualitative content

analysis of both articles and whitepaper were used. This is a multilayered investigation of the DAO literature, which is, to our knowledge, the first of its kind in the field of IB.

4. Results of Bibliometric and Content Analysis

We discuss three clusters that were observed through the bibliometric review, overviewing the key four themes present in the DAO literature that span from very technical to more business-related insights. Since the current research on DAO does not address IB-related topics or theories, in this section we only overview the findings from the literature review, and in the Discussion section we then provide reflections on the DAO research with relevance to the field of IB.

4.1. Research streams and themes within the DAO-related literature

Figure 1 uses VowViewer to show a network of bibliographic couplings containing three clusters in the field of DAOs and Blockchain Technology. The colors reveal the different clusters, and each node represents an article from the data collection. *Red*: Cluster 1 – DAOs, Governance, Legal, and Socioeconomic Implications. This cluster explores the governance, legal, and socio-economic implications of DAOs, reflecting on their influence on organizational management and societal structures. *Green*: Cluster 2 – Fundamentals in Blockchain, Smart Contracts, and DAOs. This cluster focuses on the technological bedrock of DAOs, highlighting their potential to revolutionize sectors through decentralization. *Blue*: Cluster 3 –Applications, Security, and Technical Attributes of Blockchain Technology. This cluster showcases practical applications and security measures, emphasizing the innovative strategies to secure these systems against vulnerabilities.

Fig1. Network of Bibliographic Coupling in DAO-related literature
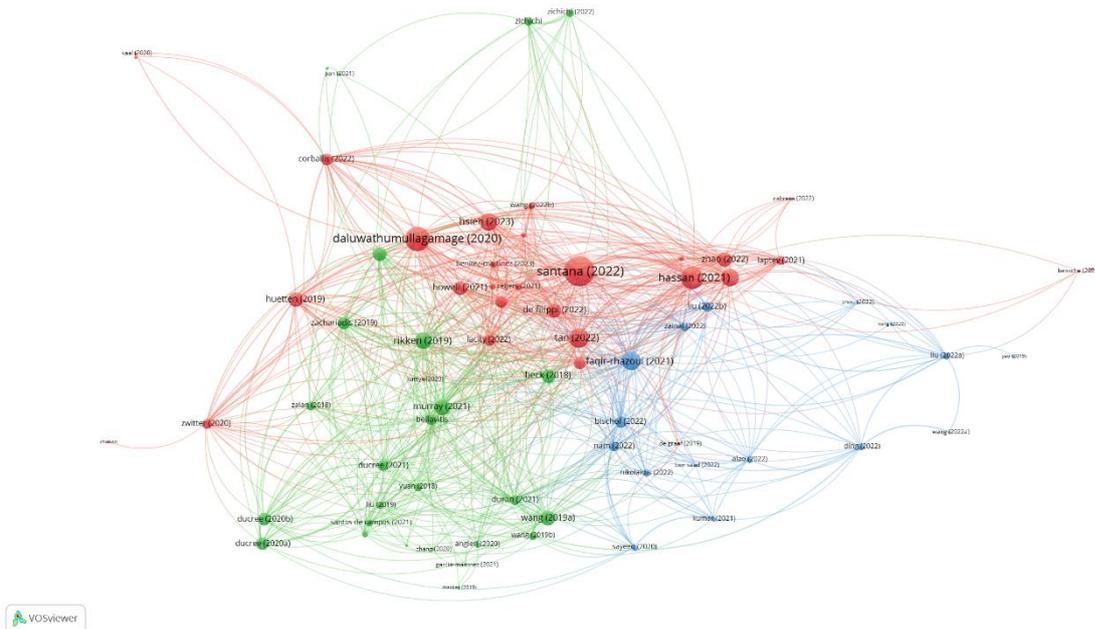
The first cluster, entitled "DAOs: Governance, Legal, and Socioeconomic Implications," encompasses three research streams. The first stream includes articles that examine blockchain governance and its legal and regulatory ramifications, such as accountability and contract law. The second stream explores the impact of DAOs and blockchain technologies on society and organization. The third stream is dedicated specifically to DAOs, analyzing their structure and distinctive features from the perspective of social sciences.

The second cluster, entitled "Fundamentals in Blockchain, Smart Contracts, and DAOs," consists of early articles that focus on foundational concepts and ideas and includes three distinct research streams. The first stream emphasizes management control and decision rights rather than legal implications. The second stream explores various blockchain applications, such as decentralized voting systems, IP address management, and data privacy solutions. The third stream delves into the technical underpinnings of blockchain, smart contracts, and DAOs, providing comprehensive overviews of how these technologies function.

The third cluster, entitled "Applications, Security, and Technical Attributes of Blockchain Technology (BLT)," comprises two research streams. The first stream focuses on applications of blockchain technology, paralleling the second research stream in Cluster 2. The second stream centers on the technical aspects of this emerging technology and the security measures designed to prevent attacks. After considering thematical overlaps in the research streams

identified in each cluster, we suggest four themes that meaningfully encompass all themes currently explored in the DAO-related research. Table 2 provides a list of works that were assigned to each research stream with bolded papers that are well cited.
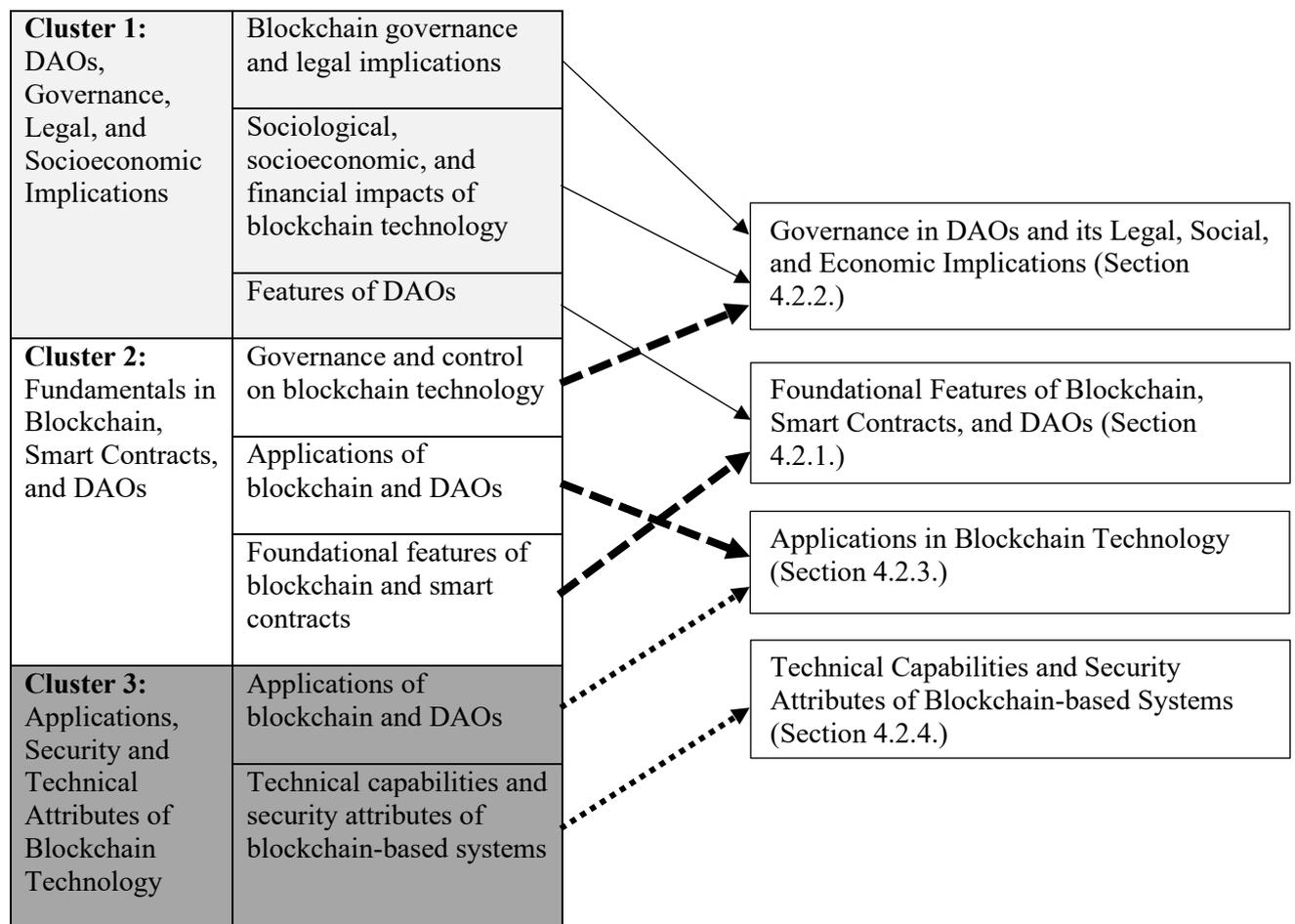
Table 2. Articles within each research stream and the methodologies used in them

Clus ter	Stre am	Articles in each Stream
1	1.1	**Blockchain governance and its policy and legal implications:** 2018: Muehlemann, 2018 (conceptualizes technology protocol and illustrates its functionality with use-cases) 2019: de Graaf, 2019 (conceptual with case examples), Hutten, 2019 (conceptual with case examples) 2020: Daluwathumullagamage & Sims, 2020 (systematic literature review and examples of use-cases), Kutsyk, Redchenko, & Voronko, 2020 (literature review), Zwitter & Hazenberg, 2020 (conceptual) 2021: Howell & Potgieter, 2021 (a single case study), Laptev & Feyzrakhmanova, 2021 (literature review), **Reijers et al., 2021** (conceptual with a case example) 2022**:** Benitez-Martinez et al., 2022 (e-Delphi study), De Filippi, Mannan, & Reijers, 2022 (conceptual), Tan et al., 2022 (systematic literature review), Wang & Zhong, 2022 (comparative analysis, technological simulative model design), Zhao, Ai, Lai, Luo, & Benitez, 2022 (quantitative, testing of transactions within a single case)
1	1.2	**Sociological, socioeconomic, and financial impacts of blockchain technology:** 2018: Freund & Stanko, 2018 (conceptual with case examples) 2019: Hoffmann & Dahlinger, 2019 (futuristic case study) 2021: Beniiche, Ebrahimzadeh, & Maier, 2021 (conceptual with technology-based simulations) 2022**:** Chohan, 2022 (case study), Corballis & Soar, 2022 (a single case), Harwick & Caton, 2022 (conceptual), Hsieh & Vergne, 2022 (mix-method study: fuzzy-set qualitative comparative analyses (QCA) and interviews), Lacity, 2022 (conversation, conceptual), Nabben & Rennie, 2022 (conceptual)
1	1.3	**Features of DAOs from social sciences side:** 2018: **Hsieh et al., 2018** (conversation, conceptual with the case examples) 2020: Kaal, 2020 (conceptual with case examples) 2021: Dwivedi et al., 2021 (code for governance development and testing), **Hassan & De Filippi, 2021** (conceptual)**,** Liu, Zhou, Huang, & Zheng, 2021 (literature review), 2022**:** Cabrera, Nickson, Roland, Hall, & Ankel, 2022 (conceptual), **Santana & Albareda, 2022** (integrative literature review)**,** Saurabh, Rani, & Upadhyay, 2022 (systematic literature review, case study)
2.	2.1	**Governance and control on blockchain technology:** 2018: **Beck et al., 2018** (a single case study)**,** Zalan, 2018 (viewpoint), **Zamani & Giaglis, 2018** (conceptual) 2019: Rikken et al., 2019 (literature review), **Zachariadis et al., 2019** (conceptual with case examples) 2020: Morrison et al., 2020 (a single case study) 2021: Murray et al., 2021 (conceptual with case examples) 2022: Bellavitis, Fisch, & Momtaz, 2022 (empirical overview of DAO market)
2	2.2	**Applications of blockchain and DAOs:** 2019: Mackey, Shah, Miyachi, Short, & Clauson, 2019 (conceptual) 2020: Angieri et al., 2020 (conceptual with case examples), Ducree, Etzrodt, et al., 2020 (conceptual with examples), Ducree, Gravitt, et al., 2020 (conceptual with examples), S. F. Zhang, Wang, & Xiong, 2020 (technology solution presentation) 2021: De Campos, Chanel, Chauffaut, & Lacan, 2021 (technology solution presentation), Garcia-Martinez, Angieri, Liu, Yang, & Bagnulo, 2021 (technology solution presentation), J. S. Zhang et al., 2021 (technology solution presentation) 2022: Bataineh, Mardini, Khamayseh, & Yassein, 2022 (technology solution presentation), Zichichi, Serena, Ferretti, & D'Angelo, 2022 (technology solution presentation), Zichichi, Ferretti, & Rodriguez-Doncel, 2022 (technology solution presentation)

2	2.3	**Features of DAOs from the technology side:** 2018: **Yuan & Wang, 2018** (conceptual with technology case examples) 2019: C. C. Liu et al., 2019 (conceptual with technology case examples), **Wang, Ouyang, et al., 2019** (conceptual with technology case examples), **Wang, Ding, et al., 2019** (conceptual with technology case examples) 2021: Ducree et al., 2021 (conceptual), Duran & Griffin, 2021 (conceptual), Pan & Deng, 2021 (building and testing mathematical model)
3	3.1	**Applications of blockchain and DAOs (technology literature):** 2020: Kong, Zhang, Wang, & Shu, 2020 (technology solution presentation), 2021: Faqir-Rhazoui, Arroyo, & Hassan, 2021 (case study) 2022: Alao & Cuffe, 2022 (technology solution presentation), G. Liu, Chen, Han, Zhou, & He, 2022 (technology solution presentation), Y. Liu & Shang, 2022 (technology solution presentation), Nikolaidis & Refanidis, 2022 (technology solution presentation), Zainal et al., 2022 (technology solution presentation), X. Wang, Yang, Han, Wang, & Wang, 2022 (conceptual)
3	3.2	**Technical capabilities and security attributes of blockchain-based systems:** 2019: **Yao et al., 2019** (model design and simulated testing of it) 2020: **Sayeed et al., 2020** (case studies of technology) 2021: **Kumar, Kumar, Gupta, & Tripathi, 2021** (technology solution presentation and simulated testing) 2022: Ben Saad, Ksentini, & Brik, 2022 (conceptual with technology examples), Bischof et al., 2022 (conceptual with technology examples), Ding et al., 2022 (conceptual with case examples), Nam & Kil, 2022 (model development and cases), Zhou, Ma, Pan, & Zhu, 2022 (model development)

Figure 2 illustrates how overlapping themes were merged into four representative research streams existing in DAO-related literature.

Fig2. Combining Overlapping Themes Within Some of the Eight Research Streams

Cluster 1: DAOs, Governance, Legal, and Socioeconomic Implications	Blockchain governance and legal implications
	Sociological, socioeconomic, and financial impacts of blockchain technology
	Features of DAOs
Cluster 2: Fundamentals in Blockchain, Smart Contracts, and DAOs	Governance and control on blockchain technology
	Applications of blockchain and DAOs
	Foundational features of blockchain and smart contracts
Cluster 3: Applications, Security and Technical Attributes of Blockchain Technology	Applications of blockchain and DAOs
	Technical capabilities and security attributes of blockchain-based systems

Governance in DAOs and its Legal, Social, and Economic Implications (Section 4.2.2.)

Foundational Features of Blockchain, Smart Contracts, and DAOs (Section 4.2.1.)

Applications in Blockchain Technology (Section 4.2.3.)

Technical Capabilities and Security Attributes of Blockchain-based Systems (Section 4.2.4.)

We further briefly describe key themes observed within each identified research stream.

4.2.1. Foundational Features of Blockchain, Smart Contracts, and DAOs

This research stream covers the foundations of DAOs from both social perspective and technological angles (e.g., Dwivedi et al., 2021). The foundational aspects of blockchain, smart contracts, and DAOs constitute a critical area of scholarly inquiry. This stream, emerging from the earlier phases of research, addresses the evolving nature of these technologies and their organizational structures (Hassan & De Filippi, 2021; Hsieh et al., 2018). The studies in this research stream remain descriptive, largely conceptual in nature, and offer many conversations targeted at conceptualizing the emerging phenomenon of DAOs.

The studies in this research stream extensively discuss the so-called code-based governance from both social and technological angles. The *'code-is-law' governance*, often termed "trustless," governance that relies on the integrity of software and algorithms to automatically

execute transparent and enforceable rules, eliminates the dependence on trust in specific actors or institutions (De Filippi, Mannan, & Reijers, 2022). For example, using blockchain technology in DAO, cases such as CarMan publishe demand for car parts via smart contracts, specifying criteria like delivery dates and price. Unlike traditional business transactions, the blockchain enables *automated* bidding, encrypted submissions, and secure, immutable contract rules, streamlining *automated* supplier selection and ensuring transparency in transactions while preserving confidentiality (Dwivedi et al., 2021).

This and similar cases (e.g., TheDAO, Aragon, etc.) in this research stream are described suggesting the paradigm shift towards a governance model that emphasizes *immutability, transparency, decentralization,* and *automation* (Santana & Albareda, 2022), making a significant departure from traditional governance models and offering a novel approach that could redefine organizational structures and economic interactions in the digital era (Beck et al., 2018; Lumineau et al., 2021). Understanding these foundational elements is essential for the continued development and maturation of DAOs. In particular, understanding the code-based governance, which is a central feature of DAOs and their governance model (Dwivedi et al., 2021; Bellavitis, Fisch, & Momtaz, 2022), is essential as it has many legal, social, and economic implications further explored in the second research stream presented in Section 4.2.2.

4.2.2. Governance in DAOs and its Legal, Social, and Economic Implications

As defined in the previous section, DAOs are based on code-based governance, or the 'code-is-law' governing mechanism that results in substantial implications in social, legal, and economic domains. The three types of governance, including the code-based adopted in DAOs, are summarized and compared in Table 3.

Table 3. Different types of governance (based on the works of: Li (2009), Lumineau et al. (2021), and Reijers et al. (2021))

Relation-based Governance	Rule-based Governance	Code-based Governance
Laws tend to be opaque and unfair, enforcement particularistic	Laws tend to be transparent, fair, and enforcement universal	Laws tend to be transparent, immutable, fair, and enforcement universal

Relying on private and local information	Relying on public information	Relying on public and private information (On- and Off-Chain)
Implicit and non-verifiable agreements	Explicit and third-party verifiable agreements	Explicit and verifiable agreements
Person-specific and non-transferable contracts	Country-specific, public, and transferable contracts	Global, public, and transferable contracts
High entry and exit barriers	Low entry and exit barriers	Very low entry and exit barriers
Requiring minimum social order	Requiring well-developed legal infrastructure	Requiring technological infrastructure (Code is law)
Low fixed costs to set up the system, high transaction costs when executing	High fixed costs to set up the system, medium costs when executing	High fixed costs to set up the system, economies of scale when executing
High and increasing marginal costs to maintain	Low and decreasing marginal costs to maintain	Low and decreasing marginal costs to maintain
Rely on particularized trust	Rely on generalized trust	Trustless governance

Code-based governance diverges from rule-based governance in its decentralization and autonomy. The decision-making power in code-based governance is distributed among participants, negating the need for a centralized governing body or authority (Zwitter & Hazenberg, 2020). This decentralization is a hallmark of DAOs, contrasting with the centralized decision-making inherent in rule-based governance systems. The governance model employed by DAOs is akin to rule-based governance in its reliance on explicit rules. However, the immutable nature of blockchain technology, which underpins code-based governance, presents challenges to adaptability and change, distinguishing it from the more flexible, amendable nature of rule-based governance.

Exploring the implications of this innovative governance approach adopted in DAOs, the second stream of research incorporates a dual-level analysis—macro, concerning implications on policy, laws, and regulations, and meso, regarding social and economic implications of governance structures and implementation of blockchain-based DAO organizations. In this research stream, governance issues include reconciling decentralized organizations with the existing policy, legal, and regulatory frameworks (e.g., Zamani & Giaglis, 2018; Chohan,

2022) and developing supportive policy and institutional infrastructure (e.g., de Graaf, 2019; Daluwathumullagamage & Sims, 2020; Zwitter & Hazenberg, 2020). The research area also includes discussion on resolving stakeholder disagreements over decisions (e.g., Wang et al., 2019) and balancing decentralization with accountability (e.g., Reijers et al., 2018). The evolution of blockchain governance and legal frameworks has attracted significant scholarly attention, peaking in 2022, and is currently the largest of all four identified research areas (see Table 2).

At the macro level, the studies in this research stream discuss the critical divergence between code-based and rule-based governance in their operational scope and jurisdiction. Rule-based governance is inherently limited by the jurisdictional boundaries of the countries in which it operates, constraining the rules and regulations to specific geographic areas. Conversely, code-based governance is global, and therefore DAOs can be set up as global entities (Rikken et al., 2019), transcending geographic limitations and offering a universal governance framework not confined by national borders (Hsieh et al., 2018; Šilenskytė, Butkevičienė, Dhanaraj, 2022). Even if the examples, such as Kleros - Crowdsourced Online Dispute Resolution – already offer tokenized code-based dispute resolution involving jurors from anywhere in the world, the code-based governance solutions remain suitable more for routine rather than complex governance cases, in which rule-based governance retains its relevance (Howell & Potgieter, 2021). Moreover, the established global legal or policy framework around DAOs does not exist yet (Bellavitis, Fisch, & Momtaz, 2022) what creates some uncertainties and hinders or poses risks in their adoption (Duran & Griffin, 2021).

At the meso level, the effectiveness of code-based governance is debated. For example, while smart contracts in DAOs can reward participants and execute pre-agreed actions, there is no strong evidence yet that "they have any unique power to organize or control human behavior over traditional forms of organization" (Corballis & Soar, 2022, p. 6). Moreover, some argue that neither of the governance mechanisms can exist on their own. For instance, Hsieh and Vergne (2022) empirically demonstrate that code-based governance in DAOs is supported with social coordination mechanisms.

Furthermore, social and socio-technical implications of specific technology features are discussed, such as the integration of both private and public information in code-based governance, which allows for a nuanced and comprehensive governance approach,

accommodating on-chain (public) and off-chain (private) information (Reijers et al., 2021). While this dual information system enables code-based governance to provide a more adaptable and transparent governance framework than the primarily single-dimension focus of relation-based or rule-based governance systems, it also brings some challenges. The existence of multiple versions of the network can also create confusion for users and developers, leading to fragmentation of the network, such as in the case of Ethereum after The DAO attack (Morrison et al., 2020).

The literature in this research stream points to several other challenges related to DAO's governance. The elimination of third-party regulators poses various key governance questions related to decision-making authorities, security, and accountabilities in a decentralized network (Zachariadis et al., 2019). Moreover, certain challenges remain regarding who is responsible for what, who decides on changes in the blockchain application and organization, who can be held accountable for which failures, and who takes risk mitigation measures when incidents happen (Beck et al., 2018). Effective governance mechanisms are necessary to define and formalize decision-making structures in DAOs, particularly during crisis situations (Rikken et al., 2019). Finally, there are some basic barriers, such as mindset and nascent (the lack of creativity or foresight) or infrastructure barriers that are likely to hinder DAO implementation (Zamani & Giaglis, 2018). The studies rarely consider the ethical considerations in the development and application of DAOs and, particularly, how blockchain technology could be leveraged to promote socioeconomic equity and financial inclusion, despite decentralization and transparency being considered as the central features of DAOs.

Similarly, as in the first research stream, the studies in this cluster remain highly descriptive and technology-focused and barely provide discussion beyond a reflection on observed phenomena or emerging possibilities from technology adoption. In the entire cluster, there is only one IB-focused study by Zalan (2018) – a viewpoint paper concerning the international entrepreneurship research that suggests that DAOs are well positioned to advance theories related to born globals. The later paper also suggests that DAOs are primarily to be studied through the digital platforms and ecosystems perspective due to their unique form of governance and network effect in their internationalization process, resembling later calls, such as in Šilenskytė et al. (2024). In the cluster, the DAO governance is described from the technology and community point of view with only minor positioning within several theories

(cf. Daluwathumullagamage & Sims, 2020; Santana & Albareda, 2022), among which the most popular and relevant to the field of IB are agency, transaction cost, and institutional theories.

Agency theory examines issues arising from information asymmetry and misalignment of incentives between principals and agents (Jensen & Meckling, 1976). The literature on DAO suggests that smart contracts may reduce certain agency costs by directly encoded rules to govern relationships. However, agency challenges persist due to difficulties enforcing decentralized contracts, especially during crises (Murray et al., 2021). *Transaction cost theory* posits that firms exist primarily to minimize coordination costs (Coase, 1937). Accordingly, automation and disintermediation in DAOs can substantially lower costs of transactions and interactions (Wang et al., 2019). However, this lens does not directly address non-economic costs of decentralized governance stemming from, for instance, inflexibility of the code (cf. Murray et al., 2021) and therefore invites further research on what kind of costs and with what impact are present once 'code-is-law' is applied (cf. Lumineau et al., 2021) in DAOs within the local and international settings of the firm's governance.

There have also been discussions about blockchain as an institutional technology (e.g., Davidson et al., 2018; Hassan & De Filippi, 2021) that would indicate institutional theory being a relevant theoretical lens. *Institutional theory* examines how organizational forms and behaviors evolve in relation to their institutional environment. The theory elucidates the formal and informal rules that orchestrate human interaction, emphasizing the critical role these rules play in shaping economic performance. This theoretical framework distinguishes between institutions, which comprise formal rules, informal constraints, and enforcement characteristics, and organizations, defined as groups of individuals engaged in collective, goal-oriented activities (DiMaggio & Powell, 1983). Within this paradigm, the institutional framework and the technology employed are pivotal in determining transaction costs, which, in turn, influence economic performance. The theory underscores the significance of institutions in mitigating uncertainty and organizing human interaction, albeit recognizing that outcomes may not always align with efficiency due to the actors' incomplete information, which affects their decision-making processes. Transaction costs emerge predominantly because information distribution is costly and asymmetrically held by the parties involved in an exchange, leading to market imperfections. Despite this, institutional innovations have been

instrumental in lowering transaction costs and enhancing the gains from trade, albeit without necessarily fostering conditions for efficient markets (DiMaggio & Powell, 1983).

In the realm of DAOs, governance becomes institutionalized by technology (Davidson et al., 2018; Hassan & De Filippi, 2021), and structures are codified and deployed on the blockchain through smart contracts. This code-based governance mirrors rule-based governance to an extent, as both frameworks depend on explicit rules to regulate organizational behavior. However, the comparison reveals significant distinctions. Rule-based governance, characterized by laws and regulations enforced by a central authority, aims to be transparent, fair, and uniformly applied. In contrast, code-based governance leverages computer code, such as smart contracts, to automate the execution of rules without human intervention. The specificity and precision of code-based rules exceed those in rule-based governance due to the necessity of executing these rules exactly as written. However, the simplified view on institutions received critique (Frolov, 2021) and requires further investigation.

Not common in the IB field but highly useful in the DAO context is the *game theory,* which models strategic decision-making between self-interested actors. It offers useful perspectives on designing incentives and governance schemes to promote participation in DAOs (cf. Daluwathumullagamage & Sims, 2020; Santana & Albareda, 2022). This theory has been applied and might be useful to further theorize DAO governance, even if game theory-based models may be complex to apply given the dynamic nature of decentralized organizations.

4.2.3. Applications in Blockchain Technology

The application stream highlights the transformative potential of DAOs in various sectors including enterprise management and the sharing economy, and provides examples of DAO applications in the context, such as shared scientific publishing management (Mackey, Shah, Miyachi, Short, & Clauson, 2019), managing global sustainability-related actions (Ducree, Etzrodt, et al., 2020), open platform strategy for science (Ducree, Gravitt, et al., 2020), health applications in IoT (Bataineh et al., 2022), IoT network trust enabling solutions (G. Liu, Chen, Han, Zhou, & He, 2022), large-scale e-voting (Zhang, Wang, & Xiong, 2020), surveillance systems (De Campos, Chanel, Chauffaut, & Lacan, 2021), finance (Faqir-Rhazoui, Arroyo, & Hassan, 2021), data management (J. S. Zhang et al., 2021; Zainal et al., 2022; Zichichi, Ferretti, & Rodriguez-Doncel, 2022), agricultural water rights trade management (Y. Liu & Shang,

2022), incentivization (Nikolaidis & Refanidis, 2022), power systems (Kong, Zhang, Wang, & Shu, 2020), metaverse (Wang, Yang, Han, Wang, & Wang, 2022), or renewable energy-related solutions (Alao & Cuffe, 2022).

The studies on DAO applications are primarily published in technology journals and methodologies focus extensively on presenting, testing, or discussing technology solutions. The existing studies on DAO applications do very little to bridge technology and business perspectives. For this reason, we further delve into DAO applications in finance - Decentralized Finance (DeFi) DAOs, – which may appear the most IB-relevant and could build this missing bridge between the technology and (international) business literature.

DeFi DAOs are one of the widest applications of DAO. DeFi DAOs have gained significant traction over the past few years, providing a range of services such as lending, trading, insurance, and asset management, among others. These financial services are highly regulated locally, regionally, and internationally, but also are central for conducting international business, which, therefore, makes the DeFi DAO applications particularly interesting to the IB scholarship. Table 4 shows the ten largest DeFi DAOs by market capitalization as of March 14th, 2023 (CoinMarketCap, 2023), some of which we explore more in depth.

Table 4. Ten Largest DeFi DAOs by Market Capitalization (CoinMarketCap, 2023)

#	DeFi DAO (Symbol)	Market Cap
1	Compound (COMP)	$4.6 billion USD
2	Aave (AAVE)	$3.7 billion USD
3	Uniswap (UNI)	$3.2 billion USD
4	MakerDAO (MKR)	$1.8 billion USD
5	SushiSwap (SUSHI)	$1.6 billion USD
6	Curve DAO (CRV)	$1.2 billion USD
7	Yearn.finance (YFI)	$1.1 billion USD
8	Balancer (BAL)	$757 million USD
9	Synthetix (SNX)	$653 million USD
10	Bancor (BNT)	$431 million USD

Compound and Aave are decentralized lending and borrowing platforms (Aave, 2020; C. Labs, 2018). Meanwhile, Uniswap and Sushiswap serve as a decentralized exchange platform for blockchain-based tokens (docs.sushi, 2022b; hackmd, n.d.), while MakerDAO (MKR) operates as a decentralized platform for issuing and governing stablecoins (MakerDAO, 2017). These DeFi platforms provide open, transparent, and accessible financial products and services online

without being strongly bound to local or regional legal frameworks. Table 5 provides a more detailed summary of the five largest by market capitalization DeFi DAOs, including their major features.

Table 5. Detailed Matrix of Top 5 Largest DeFi DAOs by Market Capitalization

Category	Compound (COMP)	Aave (AAVE)	Uniswap (UNI)	MakerDAO (MKR)	SushiSwap (SUSHI)
Application	Decentralized lending and borrowing platform	Decentralized lending and borrowing platform	Decentralized exchange platform for blockchain-based tokens	Decentralized platform for issuing and governing stablecoins	Decentralized exchange platform for blockchain-based tokens
Governance	Decentralized Governance, using governance token (COMP) with proportional voting power.	Decentralized Governance, using governance token (AAVE) with proportional voting power.	Decentralized Governance, using governance token (UNI) with proportional voting power.	Decentralized Governance, using governance token (MKR) with proportional voting power.	Decentralized Governance, using governance token (SUSHI) with proportional voting power.
Decentralization/ Centralization	Potential risk of centralization due to large token holders; Measures taken: Timelocks	Potential risk of centralization due to large token holders; Measures taken: Cooldown Mechanism	Potential risk of centralization due to large token holders; Measures taken: Timelocks	Potential risk of centralization due to large token holders; Measures taken: Debt Ceiling	Potential risk of centralization due to large token holders; Measures taken: Timelocks
Security	Bug Bounty Program, formal verifications, security audits; Audited smart contracts by third-party security firms	Bug Bounty Program, formal verifications, security audits; Audited smart contracts by third-party security firms	Bug Bounty Program, formal verifications, security audits; Audited smart contracts by third-party security firms	Bug Bounty Program, formal verifications, security audits; Audited smart contracts by third-party security firms	Bug Bounty Program, formal verifications, security audits; Audited smart contracts by third-party security firms
Scalability	Layer 1: Ethereum 2.0 Layer 2: Polygon, zkSync	Layer 1: Ethereum 2.0 Layer 2: Polygon, Aave Arc (collateral)	Layer 1: Ethereum 2.0 Layer 2: Optimism, Arbitrum, zkSync	Layer 1: Ethereum 2.0 Layer 2: StarkNet, Optimism, Arbitrum	Layer 1: Ethereum 2.0 Layer 2: Optimism, Arbitrum, zkSync
Regulation	Potential regulatory uncertainty in some jurisdictions	Electronic Money Institution license from the UK	Potential regulatory uncertainty in some jurisdictions	Potential regulatory uncertainty in some jurisdictions	Potential regulatory uncertainty in some jurisdictions

		Financial Conduct Authority			

All of these DeFi platforms utilize decentralized governance through their respective governance-tokens, which grant proportional voting power to their token-holders (Aave, 2020; Adams, Zinsmeister, Salem, Keefer, & Robinson, 2021; CryptoLibrary, 2023; docs.sushi, 2022a; C. Labs, 2022b; MakerDAO, 2017). This decentralized governance model allows for greater transparency and community involvement in the decision-making process for these platforms. However, there is a potential risk of centralization if the top investors for all the DeFi DAOs hold a large percentage of governance-tokens.

To address this concern, each platform has implemented various measures. Aave has implemented cooldown mechanisms, which require token-holders to wait a certain amount of time before being able to vote or take other actions on the platform (Dodao, n.d.). This helps to prevent large token-holders from making hasty or unilateral decisions that could lead to centralization. Compound, Uniswap, and SushiSwap have implemented timelocks, which delay the execution of certain actions on the platform for a specified amount of time (C. Labs, 2022b; SolidityDevStudio, 2022; Uniswap, n.d.). This helps to ensure that decisions are made with careful consideration and in the best interest of the community, rather than by large token-holders seeking to increase their own power. MakerDAO has implemented a debt-ceiling mechanism, which limits the amount of stablecoins that can be minted based on the collateral held in the system (MakerDAO, 2017). This helps to prevent large token-holders from dominating the platform and ensures a more equitable distribution of power among users. By implementing these various measures, these DeFi platforms aim to mitigate the potential for centralization and ensure a fair and democratic governance process for all users.

Security as a fundamental aspect of their operations is a high priority for each of these DeFi platforms. To ensure the security and safety of their users and assets, each platform has implemented a range of security measures, including bug bounty programs, formal verification, and security verifications, with all smart contracts audited by third-party security firms. These measures help to identify and mitigate potential security vulnerabilities and ensure that the platforms are able to provide a secure and reliable environment for the users (Aave, 2023; GitHub, 2023; C. Labs, 2022a; security.makerdao, n.d.).

Regulation is a significant challenge facing DeFi platforms, as they operate in a largely unregulated environment. Each platform faces potential regulatory uncertainty in some jurisdictions. However, Aave has taken steps to address this issue by obtaining an Electronic Money Institution (EMI) license from the UK Financial Conduct Authority. This license allows Aave to provide financial services for organizations in the UK and demonstrates a commitment to compliance and regulatory oversight (Paypers, 2023).

Despite the promise, challenges such as governance centralization, security, and scalability persist. This governance model, characterized by global, public, and transferable contracts, raises significant questions about accountability and compliance, particularly as four of the top five DeFi DAOs, excluding Aave, operate outside conventional regulatory frameworks (Paypers, 2023). Addressing these issues requires ongoing research into the technical and organizational mechanisms of DAOs, especially when DAO applications aim to substitute services in traditionally highly regulated industries nationally and internationally. Further research is needed to evaluate how DAOs can mitigate the risks of centralization and ensure equitable governance and what are the emerging applications of DAOs beyond DeFi, and how they can be realized.

4.2.4. Technical Capabilities and Security Attributes of Blockchain-based Systems

Security and scalability (the ability of a system to handle increasing amounts of data and transactions without sacrificing performance or security (Buterin, 2014)) emerge as paramount concerns for DAOs, with the literature highlighting various risks and proposing solutions. The study by Wang et al. (2019) is particularly noteworthy, offering a comprehensive examination of the intricacies of blockchain-enabled smart contracts. This seminal work elucidates their operational mechanisms, proposes a conceptual framework, explores application scenarios, and articulates the challenges and prospects. Similar comprehensive overviews and thematic focus on Governance, Security, and Scalability are evident in the contributions by Aave (2020), Labs (2018), and others within our top ten list, attesting to their centrality in blockchain and DAO-related research. The balance between decentralization, security, and efficiency remains a core challenge, necessitating further investigation into layer 2 solutions and the robustness of smart contracts (Yuan & Wang, 2018; Sayeed et al., 2020).

There have been several documented attacks in public permissionless blockchain-based networks that raise questions about the trustworthiness of the code-based governance and its ability to solve agency-related concerns. The most well-known attack is TheDAO attack, which exploited a vulnerability in the smart contract to steal approximately $50 million worth of Ether in 2016. The DAO incident underscores the challenges of blockchain governance and legal frameworks, highlighting the lack of judicial infrastructure to address breaches within these systems (Morrison et al., 2020). This event epitomizes the crisis situations DAOs may face, emphasizing the need for robust governance models that can navigate such complexities. Other attacks include the Parity Wallet hack, where an attacker exploited a vulnerability in the Parity multi-signature wallet code to steal approximately $30 million worth of Ether in 2017, and the King of the Ether Throne attack, which exploited a vulnerability to win the entire balance of a flawed contract in 2016. These attacks demonstrate the importance of identifying and addressing vulnerabilities in smart contract codes to prevent potential exploitation (Sayeed et al., 2020).

Thus, further research is needed in this area to investigate the way technology can deliver the promise of code-based law without compromising security when the network is growing. Future research around the technical capabilities and security may include questions such as how can DAOs enhance their security frameworks to mitigate risks associated with smart contracts and blockchain vulnerabilities, as well as what are the most effective scalability solutions for maintaining the efficiency of DAOs without compromising security or decentralization.

5. Discussion on DAO-related research and Its Implications to the field of International Business

DAOs represent a potentially transformative but nascent organizational form facing issues spanning technology, governance, regulation, and adoption. Ongoing research aims to capitalize on their opportunities while navigating various challenges. The delineation of the clusters facilitated a nuanced discussion on four research streams, offering a window into the developments and trends shaping DAOs. This discourse not only enhances our comprehension of DAOs and their potential to redefine organizational operations, automate decision-making,

and bolster transparency and accountability but also posits critical research questions to guide future scholarly endeavors.

In the field of IB, there have been first attempts to make sense of these organizations (cf. Zalan (2018), Singh et al. (2023), Šilenskytė et al. (2024) and with this more systematic overview of DAO research, we intend to present further research agenda indicating the areas where DAO could change currently existing assumptions about governing and performing IB operations at macro, meso, and micro levels of analysis.

5.1. Macro perspectives on DAO implications to IB

As discussed, DAO as an organization operates across borders and jurisdictions. While it currently is an object that suffers from institutional voids, it also has the possibility to make IB transactions more inclusive and less vulnerable to political environments, given that it operates in a virtual dimension and is based on automated, pre-defined, code-based transactions. Thus, DAO as an organizational form allows creating and managing MNCs or DPEs that can transact with countries in which the legal or financial environment is currently underdeveloped in a trustworthy and predictable manner, potentially lessening the divide between the Global North and the Global South. Furthermore, DAOs are likely to bring new funding and governance mechanisms for the countries currently in crisis (e.g., UkraineDAO) or those where a limited number of citizens have access to the services of financial institutions. However, as code-based governance remains a subject to security and legitimization issues, further research is needed on how this DAO potential could be realized.

DAOs may reduce the levels of corruption since investments and purchases of expensive goods (e.g., digital art objects) through DAOs happen in a transparent, traceable, and fixated manner. In fact, there are several cases that indicate how the Bitcoin network has already been used to trace and eliminate illegal international financial transactions. Thus, in terms of financial, social, legal, and democratic governance, DAOs offer several promising IB research questions to be explored. These include, but are not limited to the following considerations:

Institutional environment: If and how can DAO help overcome institutional voids present in various regions, especially the Global South? Can DAOs contribute to the global financial inclusion and the creation of global financial institutions that are not vulnerable to various manipulations causing global financial crises? Can DAOs contribute to the promotion and

establishment of democratic governance across the world, providing a framework for secure democratic voting in every country? Can code-based governance overtake the rule- and relation-based governance frameworks currently dominating in the international business environment? In what ways does the adoption of DAOs affect levels of corruption in various countries? What policy and legal frameworks are needed to legitimize DAO operations locally, regionally, and internationally? Are these policies and legal frameworks DAO application-sensitive? Can DAOs become a tool to avoid international sanctions imposed on specific countries or regions?

Global business environment: How will more frequent applications of DAOs in various services and operations affect globalization and the global business environment? Can Global Value (GVC) and Supply Chains (GSC) regionally and globally be automated through the adoption of DAOs? To what extent and in what ways code-based governance and DAO adoption alter the transactions in GVC and GSC?

Sustainability and crisis management: How adoption of DAOs affect global sustainability-oriented actions? How does DAO adoption relate to different dimensions of sustainability actions globally and locally? How can DAOs contribute to the country-level crisis management, such as directly and reliably providing support to the country at war?

Institutional and transaction cost theories are likely to dominate these investigations; however, new theoretical explorations would be highly encouraged. IB researchers are likely to be forced to expand their methodological horizons when exploring these questions and borrow from technology-oriented research, since technology knowledge and ways to explore DAOs are likely to require obtaining and analyzing new kinds of data, such as transactions within DAOs. Data quality and accessibility will be an additional challenge, because investigation of transactions on public permissionless blockchain-based networks may be anonymized or performed through VPN resulting in failure to identify the origin country of the transaction (cf., Šilenskytė et al., 2022).

5.2. Meso perspectives on DAO implications to IB

Meso issues in IB concern issues related to business network management, business model development and management, corporate management, and headquarters-subsidiary relationships. For each of these areas, research on DAOs offers very interesting implications.

Business network theorization in IB and DAOs. DAO as an organizational form has very vague boundaries. Thus, due to DAO features, not only internal network management (Forsgren, Holm, & Johanson, 2007) becomes more codified and automated, but also external business network management (Forsgren et al., 2007) may become easier as well. Can DAO help overcome challenges related to finding, establishing, and utilizing business networks for international operations? Do the tensions between internal and external business networks disappear, if DAO is adopted as a governance form? How does DAO, being a decentralized organization, affect relationships with business networks in different countries? Do ways of developing business relationships change when DAO is adopted for IB operations?

DPEs and DAOs: Public permissionless blockchain has already been argued to create collective virtual enterprises that constitute distributed, sharedly governed DPEs in which benefits are shared by the entire network (Šilenskytė et al., 2024). How are the network affect and network externalities (Stallkamp & Schotter, 2021) affected in DAO-based DPEs? Do DAOs create long-awaited DPEs without borders? How to design and effectively manage blockchain-based global DPEs that integrate multiple technologies, such as IoT and AI (Beniiche et al., 2021; Šilenskytė et al., 2024)? Digital platform and ecosystem literature in IB could be significantly enriched with the investigation of DAOs (Zalan, 2018).

MNC management theorization: Regarding the corporate management and headquarters-subsidiary relationships, DAOs also bring new questions to be explored. Can DAO be used as a standardization mechanism (Kim, Park, & Prescott, 2003), effectively substituting currently available integration through standardization mechanisms? How does adoption of DAOs change control readjustment practices (Stendahl et al., 2021) in MNCs? Can headquarters-subsidiary relationships (Kostova, Marano, & Tallman, 2016) become less challenging if transactions are to be managed through DAO?

Exploration of DAOs are likely to refine the above-mentioned international management theorizations. Methodologically, it may mean that IB researchers may need to consider innovative data collection methods, such as virtual ethnography (Vesa & Vaara, 2014), simulative code for governance development and testing (e.g., Dwivedi et al., 2021), or futuristic case study designs (e.g., Hoffmann & Dahlinger, 2019).

5.3. Micro perspectives on DAO implications to IB

Finally, at a macro level, especially when considering task allocation and division across borders in the form of Global Virtual Teams (GVTs), DAOs raise questions about the potential shift in GVT management. Moreover, the questions of hiring and managing a workforce across borders and 'hunting' for the best candidates globally should also be reconsidered, if DAO is being adopted. E-Delphi studies (e.g., Benitez-Martinez et al., 2022), already mentioned virtual ethnographies would be helpful in these investigations in addition to traditionally applied research methods.

Managing Global Virtual Teams with DAOs. Free riding and biases in GVT member evaluations are common (Tavoletti et al., 2022); however, task allocation and evaluation through code-based governance would allow diminishing these biases and focusing only on the outcomes that were initially defined and verified through the bias-free technological rather than biased human assessment. Many cross-cultural conflicts in organizing and management typically are present in a multicultural and multilingual workplace (e.g., Brett, 2018; Tange & Lauring, 2009); however, since management through DAO happens by self-assigning to prior defined tasks and therefore agreeing with the pre-defined, codified task and evaluation system, DAO adoption for organizing in a culturally diverse workplace may reduce various conflicts and costs related to cultural differences. Do GVT become more effective and efficient if their work is organized by using DAO?

Cross-cultural management. Furthermore, IB scholars may be interested in exploring questions, such as: to what extent and in what ways DAO adoption for organizing reduces culture and language related conflicts at work in MNCs? Can mistakes and misunderstandings in multicultural workplaces be avoided, if the workforce is managed through DAOs? Is there a better chance to hire the best candidates globally, if they are recruited through DAO defined tasks rather than contractual agreements and headhunting? These and many other questions within cross-cultural management and international human-resource management literature could be explored when researching public permissionless blockchain enabled code-based governance and its adoption in DAOs.

6. Conclusion

This article has provided a comprehensive bibliometric and content analysis of the literature on DAOs, elucidating the current state of research, key themes, and influential works in the field as well as its most prominent applications, such as DeFi. By employing a rigorous methodology that included an expanded keyword search and clustering techniques, we identified 73 relevant articles and categorized them into three main clusters that cover DAO concept and its central features, social, legal, economic, and policy implications of DAO adoption, security and accountability concerns, and the DAO applications. As the current research on DAOs provides very scarce implications for IB, in the discussion, we elaborate on what this emerging phenomenon means for the IB theory and practice.

The findings obtained via literature review invite further investigations on the governance frameworks that can balance the decentralized nature of DAOs with effective decision-making processes, especially in crisis situations and under local, regional, and global institutional voids. The security and scalability of blockchain systems remain a crucial challenge that warrants further investigation. The socioeconomic impacts of DAOs and DeFi calls for further investigation, particularly in terms of their potential to democratize financial services and disrupt traditional economic models. Additionally, exploring the intersection of DAOs with other emerging technologies, such as artificial intelligence and the Internet of Things, could provide new avenues for innovation. In the field of IB, DAOs are invited to revisit some of the major theorizations on various aspects of organizing and conducting international business at the three levels of analysis (macro, meso, and micro). Moreover, a cross-disciplinary research approach has a strong potential to expand the scope of IB research methodologies with innovative methods better suited to capture the global virtual phenomenon of code-based governance as well as its implications for the institutional environment, strategic MNCs, DPEs, and cross-cultural management.

By addressing the identified research gaps, scholars can contribute to the maturation and broader understanding of DAOs and DeFi, ultimately driving innovation and efficiency in various sectors. Our work serves as a critical resource for scholars seeking to navigate the complexities of this rapidly evolving field and provides a roadmap for future investigations that can shape the trajectory of decentralized technologies.

References

Aave. (2020). Aave Protocol Whitepaper v1.0. Retrieved from https://github.com/aave/aave-protocol/blob/master/docs/Aave_Protocol_Whitepaper_v1_0.pdf

Aave. (2023). Security & Audits. Retrieved from https://docs.aave.com/developers/deployed-contracts/security-and-audits

Adams, H., Zinsmeister, N., Salem, M., Keefer, R., & Robinson, D. (2021). Uniswap v3 Core. Retrieved from https://uniswap.org/whitepaper-v3.pdf

Apriliyanti, I. D., & Alon, I. (2017). Bibliometric analysis of absorptive capacity. International Business Review, 26(5), 896-907.

Alao, O., & Cuffe, P. (2022). Structuring Special Purpose Vehicles for Financing Renewable Generators on a Blockchain Marketplace. Ieee Transactions on Industry Applications, 58(2), 1478-1489. doi:10.1109/tia.2021.3135252

Alon, I., Apriliyanti, I. D., & Henríquez Parodi, M. C. (2021). A systematic review of international franchising. Multinational Business Review, 29(1), 43-69.

Angieri, S., Garcia-Martinez, A., Liu, B. Y., Yan, Z. W., Wang, C., & Bagnulo, M. (2020). A Distributed Autonomous Organization for Internet Address Management. Ieee Transactions on Engineering Management, 67(4), 1459-1475. doi:10.1109/tem.2019.2924737

Banalieva, E. R., & Dhanaraj, C. (2019). Internalization theory for the digital economy. *Journal of International Business Studies*, *50*, 1372-1387.

Bargoni, A., Alon, I., & Ferraris, A. (2023). A systematic review of family business and consumer behaviour. Journal of Business Research, 158, 113698.

Bashir, I. (2017). *Mastering blockchain*. Packt Publishing Ltd.

Bataineh, M. R., Mardini, W., Khamayseh, Y. M., & Yassein, M. M. B. (2022). Novel and Secure Blockchain Framework for Health Applications in IoT. Ieee Access, 10, 14914-14926. doi:10.1109/access.2022.3147795

Beck, R., Muller-Bloch, C., & King, J. L. (2018). Governance in the Blockchain Economy: A Framework and Research Agenda. Journal of the Association for Information Systems, 19(10), 1020-1034. doi:10.17705/1jais.00518

Bellavitis, C., Fisch, C., & Momtaz, P. P. (2022). The rise of decentralized autonomous organizations (DAOs): a first empirical glimpse. Venture Capital, 17. doi:10.1080/13691066.2022.2116797

Ben Saad, S., Ksentini, A., & Brik, B. (2022). An end-to-end trusted architecture for network slicing in 5G and beyond networks. Security and Privacy, 5(1), 19. doi:10.1002/spy2.186

Beniiche, A., Ebrahimzadeh, A., & Maier, M. (2021). The Way of the DAO: Toward Decentralizing the Tactile Internet. Ieee Network, 35(4), 190-197. doi:10.1109/mnet.021.1900667

Benitez-Martinez, F. L., Romero-Frias, E., & Hurtado-Torres, M. V. (2022). Neural blockchain technology for a new anticorruption token: towards a novel governance model. Journal of Information Technology & Politics, 18. doi:10.1080/19331681.2022.2027317

Bischof, E., Botezatu, A., Jakimov, S., Suharenko, I., Ostrovski, A., Verbitsky, A., . . . Zmudze, G. (2022). Longevity Foundation: Perspective on Decentralized Autonomous Organization for Special-Purpose Financing. Ieee Access, 10, 33048-33058. doi:10.1109/access.2022.3161392

BlockSpaces. (2023). A Starter Guide to Understanding Layer 2 Blockchains. Retrieved from https://www.blockspaces.com/blog/layer-2-blockchains-guide#:~:text=Blockchain%20Layer%202%20solutions%20are,and%20zero%20knowledge%20roll%2Dups.

Brett, J. (2018). Intercultural challenges in managing workplace conflict–a call for research. Cross Cultural & Strategic Management, 25(1), 32-52.

Buckley, P. J., & Strange, R. (2015). The governance of the global factory: Location and control of world economic activity. Academy of Management Perspectives, 29(2), 237-249.

Buterin, V. (2014). A next-generation smart contract and decentralized application platform. white paper, 3(37), 2-1.

Cabrera, D., Nickson, C. P., Roland, D., Hall, E., & Ankel, F. (2022). Distributed Autonomous Organization of Learning: Future Structure for Health Professions Education Institutions. Jmir Medical Education, 8(1), 3. doi:10.2196/28770

Caves, R. E. (1971). International corporations: The industrial economics of foreign investment. Economica, 38(149), 1-27.

Chohan, U. W. (2022). Public Value and Citizen-Driven Digital Innovation: A Cryptocurrency Study. International Journal of Public Administration, 10. doi:10.1080/01900692.2022.2043365

Chu, S., & Wang, S. (2018). The curses of blockchain decentralization. arXiv preprint arXiv:1810.02937.

Coase, R. H. (1937). The Nature of the Firm. Economica, 4(16), 386-405. doi:https://doi.org/10.1111/j.1468-0335.1937.tb00002.x

CoinMarketCap. (2023). Cryptocurrency Market Capitalizations. Retrieved from https://coinmarketcap.com/

Compund. (2022). Enable cheap, private transactions with Compound using Aztec. Retrieved from https://www.comp.xyz/t/enable-cheap-private-transactions-with-compound-using-aztec/2997

Corballis, T., & Soar, M. (2022). Utopia of abstraction: Digital organizations and the promise of sovereignty. Big Data & Society, 9(1), 12. doi:10.1177/20539517221084587

Crypto.com. (2020). Ethereum 2.0 An Introduction. Retrieved from https://assets.ctfassets.net/hfgyig42jimx/7j3AVp5aCnx2Ct2P6T6kY/e8991d5da1972d5d7602338 68f237609/Crypto.com_Macro_Report_-_Ethereum_2.0.pdf

CryptoLibrary. (2023). SushiSwap – SUSHI. Retrieved from https://yourcryptolibrary.com/coin/sushiswap/

Cryptorubic. (2021). SushiSwap for Polygon Network is now live! Retrieved from https://cryptorubic.medium.com/sushiswap-for-polygon-network-is-now-live-157741591467

Daluwathumullagamage, D. J., & Sims, A. (2020). Blockchain-Enabled Corporate Governance and Regulation. International Journal of Financial Studies, 8(2), 38. doi:10.3390/ijfs8020036

Davidson, S., De Filippi, P., & Potts, J. (2018). Blockchains and the economic institutions of capitalism. *Journal of Institutional Economics*, *14*(4), 639-658.

De Campos, M. G. S., Chanel, C. P. C., Chauffaut, C., & Lacan, J. (2021). Towards a Blockchain-Based Multi-UAV Surveillance System. Frontiers in Robotics and Ai, 8, 15. doi:10.3389/frobt.2021.557692

De Filippi, P., Mannan, M., & Reijers, W. (2022). The alegality of blockchain technology. Policy and Society, 41(3), 358-372. doi:10.1093/polsoc/puac006

de Graaf, T. J. (2019). From old to new: From internet to smart contracts and from people to smart contracts. Computer Law & Security Review, 35(5), 11. doi:10.1016/j.clsr.2019.04.005

DeFiSlate. (2023). The Institutional Wave: What is AAVE ARC? Retrieved from https://defislate.substack.com/p/the-institutional-wave-what-is-aave

Ding, W. W., Hou, J. C., Li, J. J., Guo, C., Qin, J. R., Kozma, R., & Wang, F. Y. (2022). DeSci Based on Web3 and DAO: A Comprehensive Overview and Reference Model. Ieee Transactions on Computational Social Systems, 9(5), 1563-1573. doi:10.1109/tcss.2022.3204745

docs.sushi. (2022a). Proposals & Voting. Retrieved from https://docs.sushi.com/docs/Governance/Proposals%20&%20Voting

docs.sushi. (2022b). What is Sushi? Retrieved from https://docs.sushi.com/docs/intro

Dodao. (n.d.). AAVE Governence. Retrieved from https://www.dodao.io/daos/aave-governence

Ducree, J., Etzrodt, M., Bartling, S., Walshe, R., Harrington, T., Wittek, N., . . . Lawton, J. (2021). Unchaining Collective Intelligence for Science, Research, and Technology Development by Blockchain-Boosted Community Participation. Frontiers in Blockchain, 4, 19. doi:10.3389/fbloc.2021.631648

Ducree, J., Etzrodt, M., Gordijn, B., Gravitt, M., Bartling, S., Walshe, R., & Harrington, T. (2020). Blockchain for Organizing Effective Grass-Roots Actions on a Global Commons: Saving the Planet. Frontiers in Blockchain, 3, 11. doi:10.3389/fbloc.2020.00033

Ducree, J., Gravitt, M., Walshe, R., Bartling, S., Etzrodt, M., & Harrington, T. (2020). Open Platform Concept for Blockchain-Enabled Crowdsourcing of Technology Development and Supply Chains. Frontiers in Blockchain, 3, 13. doi:10.3389/fbloc.2020.586525

Dunning, J. H., & Lundan, S. M. (2008). Multinational enterprises and the global economy. Edward Elgar Publishing

Duran, R. E., & Griffin, P. (2021). Smart contracts: will Fintech be the catalyst for the next global financial crisis? Journal of Financial Regulation and Compliance, 29(1), 104-122. doi:10.1108/jfrc-09-2018-0122

Dwivedi, V., Norta, A., Wulf, A., Leiding, B., Saxena, S., & Udokwu, C. (2021). A Formal Specification Smart-Contract Language for Legally Binding Decentralized Autonomous Organizations. Ieee Access, 9, 76069-76082. doi:10.1109/access.2021.3081926

Faqir-Rhazoui, Y., Arroyo, J., & Hassan, S. (2021). A comparative analysis of the platforms for decentralized autonomous organizations in the Ethereum blockchain. Journal of Internet Services and Applications, 12(1), 20. doi:10.1186/s13174-021-00139-6

Forsgren, M. (2017). *Theories of the multinational firm: A multidimensional creature in the global economy*. Edward Elgar Publishing.

Forsgren, M., Holm, U., & Johanson, J. (2007). Managing the embedded multinational: A business network view. Edward Elgar Publishing.

Freund, A., & Stanko, D. (2018). The Wolf and the Caribou: Coexistence of Decentralized Economies and Competitive Markets. Journal of Risk and Financial Management, 11(2), 38. doi:10.3390/jrfm11020026

Frolov, D. (2021). Blockchain and institutional complexity: An extended institutional approach. *Journal of Institutional Economics*, *17*(1), 21-36.

Garcia-Martinez, A., Angieri, S., Liu, B. Y., Yang, F., & Bagnulo, M. (2021). Design and Implementation of InBlock-A Distributed IP Address Registration System. Ieee Systems Journal, 15(3), 3528-3539. doi:10.1109/jsyst.2020.3003526

GitHub. (2023). Uniswap Audit. Retrieved from https://github.com/ConsenSys/Uniswap-audit-report-2018-12/blob/master/Uniswap-final.md

Hackmd. (n.d.). Uniswap Whitepaper. Retrieved from https://hackmd.io/@HaydenAdams/HJ9jLsfTz#DEX-inside-a-Whitepaper

Hafid, A., Senhaji Hafid, A., & Samih, M. (2020). Scaling Blockchains: A Comprehensive Survey. Ieee Access, PP. doi:10.1109/ACCESS.2020.3007251

Hamel, G., & Prahalad, C. K. (1990). Strategic intent. Mckinsey quarterly, (1), 36-61.

Harwick, C., & Caton, J. (2022). What's holding back blockchain finance? On the possibility of decentralized autonomous finance. Quarterly Review of Economics and Finance, 84, 420-429. doi:10.1016/j.qref.2020.09.006

Hassan, S., & De Filippi, P. (2021). Decentralized Autonomous Organization. Internet Policy Review, 10(2), 10. doi:10.14763/2021.2.1556

Hennart, J. F., & Verbeke, A. (2022). Actionable and enduring implications of Oliver Williamson's transaction cost theory. Journal of International Business Studies, 53(8), 1557-1575

Hoffmann, C. H., & Dahlinger, A. (2019). How capitalism abolishes itself in the digital era in favour of robo-economic systems: socio-economic implications of decentralized autonomous self-owned businesses. Foresight, 22(1), 53-67. doi:10.1108/fs-03-2019-0014

Holm, D. B., Eriksson, K., & Johanson, J. (1996). Business networks and cooperation in international business relationships. *Journal of international business studies*, *27*, 1033-1053.

Howell, B. E., & Potgieter, P. H. (2021). Uncertainty and dispute resolution for blockchain and smart contract institutions. Journal of Institutional Economics, 17(4), 545-559. doi:10.1017/s1744137421000138

Hsieh, Y. Y., & Vergne, J. P. (2022). The future of the web? The coordination and early-stage growth of decentralized platforms. Strategic Management Journal, 29. doi:10.1002/smj.3455

Hsieh, Y. Y., Vergne, J. P., Anderson, P., Lakhani, K., & Reitzig, M. (2018). Bitcoin and the rise of decentralized autonomous organizations. *Journal of Organization Design*, *7*(1), 1-16.

Hsieh, Y. Y., Vergne, J. P., Anderson, P., Lakhani, K., & Reitzig, M. (2018). Bitcoin and the rise of decentralized autonomous organizations. Journal of Organization Design, 7(1), 16. doi:10.1186/s41469-018-0038-1

Hutten, M. (2019). The soft spot of hard code: blockchain technology, network governance and pitfalls of technological utopianism. Global Networks-a Journal of Transnational Affairs, 19(3), 329-348. doi:10.1111/glob.12217

Jalal, R. N. U. D., Alon, I., & Paltrinieri, A. (2021). A bibliometric review of cryptocurrencies as a financial asset. Technology Analysis & Strategic Management, 1-16.

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. Journal of Financial Economics, 3(4), 305-360. doi:https://doi.org/10.1016/0304-405X(76)90026-X

Kaal, W. A. (2020). Decentralized Corporate Governance via Blockchain Technology. Annals of Corporate Governance, 5(2), 101-147. doi:10.1561/109.00000025

Kim, K., Park, J. H., & Prescott, J. E. (2003). The global integration of business functions: A study of multinational businesses in integrated global industries. Journal of international business studies, 34, 327-344.

Kong, X. Y., Zhang, J. Y., Wang, H., & Shu, J. (2020). Framework of Decentralized Multi-chain Data Management for Power Systems. Csee Journal of Power and Energy Systems, 6(2), 458-468. doi:10.17775/cseejpes.2018.00820

Kostova, T., Marano, V., & Tallman, S. (2016). Headquarters–subsidiary relationships in MNCs: Fifty years of evolving research. *Journal of World Business*, *51*(1), 176-184.

Kumar, P., Kumar, R., Gupta, G. P., & Tripathi, R. (2021). A Distributed framework for detecting DDoS attacks in smart contract-based Blockchain-IoT Systems by leveraging Fog computing. Transactions on Emerging Telecommunications Technologies, 32(6), 31. doi:10.1002/ett.4112

Kutsyk, P., Redchenko, K., & Voronko, R. (2020). MANAGEMENT CONTROL AND MODERN DECENTRALIZED TECHNOLOGIES. Baltic Journal of Economic Studies, 6(4), 98-102. doi:10.30525/2256-0742/2020-6-4-98-102

Labs, C. (2018). Compound: A Protocol for Decentralized Lending on Ethereum. Retrieved from https://whitepaper.io/document/586/compound-whitepaper

Labs, C. (2022a). Audited and Verified The most secure protocol for money. Retrieved from https://compound.finance/governance/leaderboard

Labs, C. (2022b). Governance. Retrieved from https://compound.finance/docs/governance

Labs, M. (n.d.). https://ecosystem.zksync.io/. Retrieved from https://ecosystem.zksync.io/

Lacity, M. C. (2022). Blockchain: From Bitcoin to the Internet of Value and beyond. Journal of Information Technology, 15. doi:10.1177/02683962221086300

Laptev, V. A., & Feyzrakhmanova, D. R. (2021). Digitalization of Institutions of Corporate Law: Current Trends and Future Prospects. Laws, 10(4), 19. doi:10.3390/laws10040093

Li, C., Li, P., Zhou, D., Xu, W., Long, F., & Yao, A. (2018). Scaling nakamoto consensus to thousands of transactions per second. arXiv preprint arXiv:1805.03870.

Li, K., Rollins, J., & Yan, E. (2018). Web of Science use in published research and review papers 1997–2017: a selective, dynamic, cross-domain, content-based analysis. Scientometrics, 115(1), 1-20. doi:10.1007/s11192-017-2622-5

Li, S. (2009). Managing International Business in Relation-Based Versus Rule-Based Countries: Business Expert Press.

Li, S., Park, S. H., & Li, S. (2003). The great leap forward: The transition from relation-based governance to rule-based governance. Organizational Dynamics, 33(1), 63-78.

Liu, C. C., Xiao, Y. H., Javangula, V., Hu, Q., Wang, S. L., & Cheng, X. Z. (2019). NormaChain: A Blockchain-Based Normalized Autonomous Transaction Settlement System for IoT-Based E-Commerce. Ieee Internet of Things Journal, 6(3), 4680-4693. doi:10.1109/jiot.2018.2877634

Liu, G., Chen, C. Y., Han, J. Y., Zhou, Y., & He, G. B. (2022). NetDAO: Toward Trustful and Secure IoT Networks without Central Gateways. Symmetry-Basel, 14(9), 15. doi:10.3390/sym14091796

Liu, L., Zhou, S. C., Huang, H. W., & Zheng, Z. B. (2021). From Technology to Society: An Overview of Blockchain-Based DAO. Ieee Open Journal of the Computer Society, 2, 204-215. doi:10.1109/ojcs.2021.3072661

Liu, Y., & Shang, C. (2022). Application of Blockchain Technology in Agricultural Water Rights Trade Management. Sustainability, 14(12), 10. doi:10.3390/su14127017

Lumineau, F., Wang, W., & Schilke, O. (2021). Blockchain governance—A new way of organizing collaborations?. *Organization Science*, *32*(2), 500-521.

Mackey, T. K., Shah, N., Miyachi, K., Short, J., & Clauson, K. (2019). A Framework Proposal for Blockchain-Based Scientific Publishing Using Shared Governance. Frontiers in Blockchain, 2, 12. doi:10.3389/fbloc.2019.00019

MakerDAO. (2017). MakerDAO Whitepaper. Retrieved from https://makerdao.com/en/whitepaper/#abstract

Makridis, C. A., Fröwis, M., Sridhar, K., & Böhme, R. (2023). The rise of decentralized cryptocurrency exchanges: Evaluating the role of airdrops and governance tokens. Journal of Corporate Finance, 79, 102358.

Marr, B. (2022) The Best Examples Of DAOs Everyone Should Know About. *Forbes*. Accessed online: https://www.forbes.com/sites/bernardmarr/2022/05/25/the-best-examples-of-daos-everyone-should-know-about/

Morrison, R., Mazey, N., & Wingreen, S. C. (2020). The DAO Controversy: The Case for a New Species of Corporate Governance? Frontiers in Blockchain, 3, 13. doi:10.3389/fbloc.2020.00025

Muehlemann, A. (2018). Sentiment Protocol: A Decentralized Protocol Leveraging Crowdsourced Wisdom. Ledger, 3, 48-59. doi:10.5195/ledger.2018.113

Murray, A., Kuban, S., Josefy, M., & Anderson, J. (2021). CONTRACTING IN THE SMART ERA: THE IMPLICATIONS OF BLOCKCHAIN AND DECENTRALIZED AUTONOMOUS ORGANIZATIONS FOR CONTRACTING AND CORPORATE GOVERNANCE. Academy of Management Perspectives, 35(4), 622-641. doi:10.5465/amp.2018.0066

Nabben, K., & Rennie, E. (2022). Ad hoc network. Internet Policy Review, 11(2), 1-11. doi:10.14763/2022.2.1666

Nam, W., & Kil, H. (2022). Formal Verification of Blockchain Smart Contracts via ATL Model Checking. Ieee Access, 10, 8151-8162. doi:10.1109/access.2022.3143145

Nambisan, S., & Luo, Y. (2021). Toward a loose coupling view of digital globalization. *Journal of International Business Studies*, *52*(8), 1646-1663.

Nikolaidis, S., & Refanidis, I. (2022). Consolidating incentivization in distributed neural network training via decentralized autonomous organization. Neural Computing & Applications, 34(22), 19599-19613. doi:10.1007/s00521-022-07374-3

North, D. C. (1992). Transaction costs, institutions, and economic performance: ICS Press San Francisco, CA.

OpenZeppelin. (2023). Compound Polygon Bridge Receiver Audit. Retrieved from https://blog.openzeppelin.com/compound-polygon-bridge-receiver-audit/

Pan, Y. G., & Deng, X. M. (2021). Incentive Mechanism Design for Distributed Autonomous Organizations Based on the Mutual Insurance Scenario. Complexity, 2021, 16. doi:10.1155/2021/9947360

Paypers, T. (2023). Aave launches regulation-compliant DeFi platform. Retrieved from https://thepaypers.com/online-mobile-banking/aave-launches-regulation-compliant-defi-platform--1253749.

Puranam, P., Alexy, O., & Reitzig, M. (2014). What's "new" about new forms of organizing?. *Academy of management Review*, *39*(2), 162-180.

Reijers, W., Wuisman, I., Mannan, M., De Filippi, P., Wray, C., Rae-Looi, V., . . . Orgad, L. (2021). Now the Code Runs Itself: On-Chain and Off-Chain Governance of Blockchain Technologies. Topoi- an International Review of Philosophy, 40(4), 821-831. doi:10.1007/s11245-018-9626-5

Rikken, O., Janssen, M., & Kwee, Z. (2019). Governance challenges of blockchain and decentralized autonomous organizations. Information Polity, 24(4), 397-417. doi:10.3233/ip-190154

Rugman, A. M., & Verbeke, A. (2003). Extending the theory of the multinational enterprise: Internalization and strategic management perspectives. Journal of international business studies, 34, 125-137

Santana, C., & Albareda, L. (2022). Blockchain and the emergence of Decentralized Autonomous Organizations (DAOs): An integrative model and research agenda. Technological Forecasting and Social Change, 182, 15. doi:10.1016/j.techfore.2022.121806

Saurabh, K., Rani, N., & Upadhyay, P. (2022). Towards blockchain led decentralized autonomous organization (DAO) business model innovations. Benchmarking-an International Journal, 28. doi:10.1108/bij-10-2021-0606

Sayeed, S., Marco-Gisbert, H., & Caira, T. (2020). Smart Contract: Attacks and Protections. Ieee Access, 8, 24416-24427. doi:10.1109/access.2020.2970495

Schueffel, P., Groeneweg, N., & Baldegger, R. (2019). The Crypto Encyclopedia: Coins, tokens and digital assets from A to Z. page 57.

security.makerdao. (n.d.). Multi-Collateral DAI (MCD) Security. Retrieved from https://security.makerdao.com/

Šilenskytė, A., & Smale, A. (2021). Multilevel theorizing in international business: the case of research on strategy implementation in MNCs. *critical perspectives on international business*, *17*(4), 502-521. https://doi.org/10.1108/cpoib-08-2019-0060

Šilenskytė, A., Butkevičienė, J., & Bartminas, A. (2024). Blockchain-based connectivity within digital platforms and ecosystems in international business. *Journal of International Management*, *30*(3), https://doi.org/10.1016/j.intman.2023.101109

Šilenskytė, A., Butkevičienė, J., Dhanaraj, C., (2022) "Digital Entrepreneurs' Strategic Responses to the Incomplete Global Policy Framework for Blockchain-Based Business" Chapter 10, p. 113-126, in Ed. J. Mark Munoz (2022) *Digital Entrepreneurship and the Global Economy*. New York: Routledge, http://dx.doi.org/10.4324/9781003194798-10

Singh, S., Gaur, A., & Singh, D. (2023). Blockchain-Based Governance: Implications for Organizational Boundaries and Structures. *British Journal of Management*.

SolidityDevStudio. (2022). SushiSwap Explained! Retrieved from https://soliditydeveloper.com/sushi-swap

Stallkamp, M., & Schotter, A. P. (2021). Platforms without borders? The international strategies of digital platform firms. Global Strategy Journal, 11(1), 58-80.

Stallkamp, M., & Schotter, A. P. (2021). Platforms without borders? The international strategies of digital platform firms. *Global Strategy Journal*, *11*(1), 58-80.

Stendahl, E., Schriber, S., & Tippmann, E. (2021). Control changes in multinational corporations: Adjusting control approaches in practice. *Journal of international business studies*, *52*, 409-431.

Strange, R., Chen, L., & Fleury, M. T. L. (2022). Digital transformation and international strategies. *Journal of International Management*, *28*(4), 100968.

support.token. (2022). How to use Uniswap on Optimism? Retrieved from https://support.token.im/hc/en-us/articles/6676198731545-How-to-use-Uniswap-on-Optimism-

support.token. (2023). How to use Uniswap on Arbitrum? Retrieved from https://support.token.im/hc/en-us/articles/5226317921305-How-to-use-Uniswap-on-Arbitrum-

Tan, E., Mahula, S., & Crompvoets, J. (2022). Blockchain governance in the public sector: A conceptual framework for public management. Government Information Quarterly, 39(1), 11. doi:10.1016/j.giq.2021.101625

Tange, H., & Lauring, J. (2009). Language management and social interaction within the multilingual workplace. Journal of Communication Management, 13(3), 218-232.

Tavoletti, E., Stephens, R. D., Taras, V., & Dong, L. (2022). Nationality biases in peer evaluations: The country-of-origin effect in global virtual teams. International Business Review, 31(2), 101969.

TheBlock. (2022). MakerDAO to integrate StarkNet to cut DAI transaction costs. Retrieved from https://www.theblock.co/post/142641/makerdao-starknet-integration-ethereum-layer-2

TheBlock. (2023). Aave eyes expansion to BNB Chain, Starknet and Polygon zkEVM. Retrieved from https://www.theblock.co/post/224760/aave-bnb-starknet-polygon-zkevm

Uniswap. (n.d.). Overview. Retrieved from https://docs.uniswap.org/contracts/v3/reference/governance/overview

Vesa, M., & Vaara, E. (2014). Strategic ethnography 2.0: Four methods for advancing strategy process and practice research. *Strategic organization*, *12*(4), 288-298.

Wang, S., Ding, W. W., Li, J. J., Yuan, Y., Ouyang, L. W., & Wang, F. Y. (2019). Decentralized Autonomous Organizations: Concept, Model, and Applications. Ieee Transactions on Computational Social Systems, 6(5), 870-878. doi:10.1109/tcss.2019.2938190

Wang, S., Ouyang, L. W., Yuan, Y., Ni, X. C., Han, X., & Wang, F. Y. (2019). Blockchain-Enabled Smart Contracts: Architecture, Applications, and Future Trends. Ieee Transactions on Systems Man Cybernetics-Systems, 49(11), 2266-2277. doi:10.1109/tsmc.2019.2895123

Wang, X., Yang, J., Han, J. P., Wang, W., & Wang, F. Y. (2022). Metaverses and DeMetaverses: From Digital Twins in CPS to Parallel Intelligence in CPSS. Ieee Intelligent Systems, 37(4), 97-102. doi:10.1109/mis.2022.3196592

Wang, Z. W., & Zhong, X. L. (2022). Stimulative Coordination Models for Cooperative and Competitive Enterprise Alliances Based on Token Economy. Ieee Access, 10, 43454-43472. doi:10.1109/access.2022.3169598

Wegner, D., Zuquetto, R. D., & Grisi, F. C. (2024). Decentralized Autonomous Organizations (DAOs): Field of Research and Avenues for Future Studies. *BAR: Brazilian Administration Review*, *21*(2).

Williamson, O. E. (1981). The economics of organization: The transaction cost approach. American journal of sociology, 87(3), 548-577

Yao, H. P., Mai, T. L., Wang, J. J., Ji, Z., Jiang, C. X., & Qian, Y. (2019). Resource Trading in Blockchain-Based Industrial Internet of Things. Ieee Transactions on Industrial Informatics, 15(6), 3602-3609. doi:10.1109/tii.2019.2902563

Yuan, Y., & Wang, F. Y. (2018). Blockchain and Cryptocurrencies: Mode Techniques, and Applications. Ieee Transactions on Systems Man Cybernetics-Systems, 48(9), 1421-1428. doi:10.1109/tsmc.2018.2854904

Zachariadis, M., Hileman, G., & Scott, S. V. (2019). Governance and control in distributed ledgers: Understanding the challenges facing blockchain technology in financial services. Information and Organization, 29(2), 105-117. doi:10.1016/j.infoandorg.2019.03.001

Zainal, D., Borda, R. F. C., Algani, Y. M. A., Yakkala, M. B., Sanjith, D. S., Muda, I., . . . Bala, B. K. (2022). A decentralized autonomous personal data management system in banking sector. Computers & Electrical Engineering, 100, 11. doi:10.1016/j.compeleceng.2022.108027

Zalan, T. (2018). Born global on blockchain. Review of International Business and Strategy, 28(1), 19-34. doi:10.1108/ribs-08-2017-0069

Zamani, E. D., & Giaglis, G. M. (2018). With a little help from the miners: distributed ledger technology and market disintermediation. Industrial Management & Data Systems, 118(3), 637-652. doi:10.1108/imds-05-2017-0231

Zhang, J. S., Xu, G., Chen, X. B., Ahmad, H., Liu, X., & Liu, W. (2021). Towards Privacy-Preserving Cloud Storage: A Blockchain Approach. Cmc-Computers Materials & Continua, 69(3), 2903-2916. doi:10.32604/cmc.2021.017227

Zhang, S. F., Wang, L. L., & Xiong, H. (2020). Chaintegrity: blockchain-enabled large-scale e-voting system with robustness and universal verifiability. International Journal of Information Security, 19(3), 323-341. doi:10.1007/s10207-019-00465-8

Zhao, X., Ai, P. L., Lai, F. J., Luo, X., & Benitez, J. (2022). Task management in decentralized autonomous organization. Journal of Operations Management, 68(6-7), 649-674. doi:10.1002/joom.1179

Zhou, Z. X., Ma, Y. F., Pan, Y. H., & Zhu, Y. G. (2022). Data envelopment analysis models based on decentralized decision making. Computers & Industrial Engineering, 170, 7. doi:10.1016/j.cie.2022.108318

Zichichi, M., Ferretti, S., & Rodriguez-Doncel, V. (2022). Decentralized Personal Data Marketplaces: How Participation in a DAO Can Support the Production of Citizen-Generated Data. Sensors, 22(16), 31. doi:10.3390/s22166260

Zichichi, M., Serena, L., Ferretti, S., & D'Angelo, G. (2022). Complex queries over decentralised systems for geodata retrieval. Iet Networks, 16. doi:10.1049/ntw2.12037

Zwitter, A., & Hazenberg, J. (2020). Decentralized Network Governance: Blockchain Technology and the Future of Regulation. Frontiers in Blockchain, 3, 12. doi:10.3389/fbloc.2020.00012