

RUNNING CODE OR BETTER CODE? EXPERTISE DE/CENTRALIZATION TENSIONS IN THE ETHEREUM BLOCKCHAIN ECOSYSTEM

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ABSTRACT

Blockchain is one of the most consequential innovations since the world wide web. Although blockchain is argued to remove, displace, or redistribute expertise, there is little understanding of the role of expertise in blockchain ecosystems, and more generally the expertise that fuels the development of new technologies by means of open, fluid, and heterogeneous knowledge contributions. An empirical study of the social organization of the Ethereum community, the second largest blockchain ecosystem after Bitcoin, reveals the contrasting tensions involved in setting up a system of decentralized expertise. The alternate community mantras “rough consensus, running code” and “wide consensus, better code?” suggest that the Ethereum community enacts expertise centralization and decentralization practices simultaneously to create a fragile balance between individualized accountabilities and a generalized sense of diffused participation. These practices unfold along a continuum of routine operations punctuated by critical events and are both essential for navigating the uncertainties of decentralized organizations. The study contributes to research on new forms of expertise occasioned by emerging technologies, and in particular to our understanding of blockchain expertise. The study’s relational

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perspective on expertise adds to research on the dynamics of knowledge delocalization in online communities.

Keywords: Blockchain; expertise; de/centralization; online communities; open source; platform ecosystems; Ethereum

INTRODUCTION

Emergent algorithmic technologies are strongly challenging traditional models of expertise organization to the extent that “one could go so far as to claim that the technology is the organization” (Alaimo & Kallinikos, 2021, p. 1402). How expertise is socially constructed and negotiated in decentralized ecosystems occasioned by emergent algorithmic technologies constitutes a new area of social inquiry (Dorschel, 2022; Kellogg et al., 2020; Susskind & Susskind, 2015). This study aims to bring attention to the decentralized forms of organization such as platforms, ecosystems, and open online communities occasioned by blockchain technology in order to encourage inquiry about the shift from traditional models of expertise based on human centralization to new models based on human-algorithm interdependencies.

Blockchain technology has been said to afford new models of social governance which are not reducible to traditional definitions of hierarchical organizations, networks, or even platforms (Davidson et al., 2018; Lumineau et al., 2021; Vergne, 2020; Zachariadis et al., 2019). By acting like databases distributed among peer-to-peer computer networks, blockchains enable transparent and immutable information exchanges without use of expert intermediaries such as regulators, banks, lawyers, accountants, or governments (Davidson et al., 2018; Felin & Lakhani, 2018; Notheisen et al., 2017). From that standpoint, blockchains promise to dismantle the premise that information is centralized systematically in the hands of the few and set the basis for the inalterable distribution of rights and responsibilities to the many. Thus, how blockchains organize expertise is raising novel theoretical and empirical questions.

Many contributions across various domains and disciplines coalesce around the functional definition of blockchain as a “trust machine” which has the power to replace trust between individuals with trust in algorithms (Davidson et al., 2018; Lumineau et al., 2021). In this view, the correct functioning of cryptographic rules, mathematics, and game-theoretical incentives allows the seamless operation of computational systems which limit or remove the need for human intervention. Yet like all technologies, blockchains need to be developed, maintained, and improved which ultimately requires human intervention (Lumineau et al., 2021). Recent studies (Alaimo & Kallinikos, 2021; Anthony, 2021; Glaser et al., 2021) argue that the algorithms driving new technologies take the form of a black box where the agency lies with the algorithm rather than the socio-technical relations and negotiations involved in their creation and deployment. As a result, humans are frequently considered passive actors, and their contributions to these technologies are undervalued.

In responding to calls for a more balanced approach that takes account of both human and algorithmic agency (Bailey et al., 2022; Faraj et al., 2018; Glaser et al., 2021; Kellogg et al., 2020; Susskind & Susskind, 2015), this study adopts a relational perspective of the expertise necessary for the creation and deployment of automatizing technologies such as blockchain (Pakarinen & Huising, 2023). On the one hand, the literature on online communities (OCs) such as open-source software communities and open innovation projects (Barrett et al., 2016; Faraj et al., 2016; Fürstenau et al., 2023; O'Mahony & Ferraro, 2007) documents trends related to the collectivization of knowledge and the decentralization of technical expertise which question much of our current knowledge about expert systems (Crowston & Howison, 2006; Dahlander & O'Mahony, 2011; Hippel & Krogh, 2003; Lyytinen et al., 2016; Safadi et al., 2021). Mathematician and computer programmer Eric Hughes coined the term cypherpunk in his 1993 manifesto, arguing that information technology could fuel collective and decentralized means of social liberation:

Cypherpunks write code. We know that someone has to write software to defend privacy, and since we can't get privacy unless we all do, we're going to write it. We publish our code so that our fellow Cypherpunks may practice and play with it. Our code is free for all to use, worldwide. We don't much care if you don't approve of the software we write. We know that software can't be destroyed and that a widely dispersed system can't be shut down (Hughes, 1993).

These ideas are echoed in the manifestos of many open-source communities dealing with technological developments including Bitcoin (Nakamoto, 2008), Ethereum (Buterin, 2014), blockchain, and OpenAI.¹

However, even in open-source environments, the power of experts such as computer programmers and data analysts is increasing and becoming the “invisible hand” behind algorithmic models and technologies (Burrell & Fourcade, 2021; Crowston & Howison, 2006; Dahlander & O'Mahony, 2011; Dorschel, 2022; Pachidi et al., 2021; Susskind & Susskind, 2015). For example, although OpenAI uses open-source data, the work of its in-house experts is opaque which allows it to retain control over certain tools such as Chat GPT for instance (Roose, 2023). Similarly, despite blockchain technology being largely open source, only a few programmers have the expertise to contribute to its development (Walch, 2019). Several studies have investigated “new” experts considering them as either the custodians of decentralization that ensure technological development, reliability, and accountability or threats to decentralization that are undermining the ideals of online communities (Crowston & Howison, 2006; Faraj et al., 2016, 2018; Safadi et al., 2021; Susskind & Susskind, 2015). However, despite this growing awareness of the contradictory tensions between the decentralized organization of new technology developments and the rise of new groups of experts, none of the literature adopts an integrative perspective.

In this context, the present study aims to shed light on the de/centralization tensions intrinsic to the relation between expertise and new forms of organization occasioned by emergent decentralized digital technologies. The study examines the social organization of the Ethereum community, the blockchain ecosystem second only to Bitcoin. The case of blockchain offers a unique opportunity to

study the paradoxical tensions entailed in the organization of a decentralized system of expertise. By design blockchain offers transparency and challenges traditional open-source models that combine openness with occasional closeness. However, similar to other technology, blockchain technology needs to be programmed, maintained, and implemented by human experts.

The case study in this paper provides a more comprehensive understanding of how blockchain technology is produced through the efforts of decentralized open-source communities in which elite developers play an important role. It provides a thick description of the Ethereum community's attempts to navigate the de/centralization tensions resulting from concerted efforts to extend the expert contributions from the broad community and invest "elite" experts with the power required to develop a reliable technology. The de/centralization tension manifests as ongoing alternating between two community mantras *rough consensus, running code* which alludes to expertise centralization practices, and *wide consensus, better code* which indicates the community's aspirations to achieve radical decentralization. These tensions occur along a continuum of routine organization punctuated by efforts to organize in times of crisis. The study contributes to the literature on algorithmic work and expertise in online communities. It emphasizes the need to move beyond dualistic views of de/centralized expertise and adopt a relational perspective on human intentions, algorithm production, hybrid ideologies, routine, and crisis organization.

THEORETICAL FRAMEWORK

Delocalization Tensions in Platform Organization and Online Communities

In an era of rapid technology advances, the boundaries between democratization and control of knowledge have become increasingly multifaceted (Burrell & Fourcade, 2021; Kallinikos et al., 2013; Yoo et al., 2012; Zuboff, 2019). Technology platforms and ecosystems, in particular, involve loosely coupled groups interacting without hierarchical command to develop new algorithmic technologies (Constantinides et al., 2018; Faraj et al., 2016; Gillespie, 2010; Lyytinen et al., 2016; O'Mahony & Ferraro, 2007; Shaikh & Vaast, 2016). OCs, such as open source software communities and open innovation crowds, have become pivotal for developing emergent technologies and are driving most of the organization of technology platforms (Faraj et al., 2016). They unite geographically dispersed individuals with diverse interests to collaborate on loosely coupled activities related to a technology or set of complementary technologies. Unlike traditional organizations, OCs have fluid membership, porous boundaries, and evolving roles and norms (Faraj et al., 2011). This flexibility allows dynamic flows of tacit and explicit knowledge, fostering an environment conducive to decentralization of expertise (Barrett et al., 2016; Faraj et al., 2016; Fürstenau et al., 2023; Safadi et al., 2021; Shaikh & Vaast, 2016; Von Krogh et al., 2003). It is being claimed that these new organizational forms are challenging traditional expertise structures but how and when requires deeper investigation (Susskind & Susskind, 2015). So far, studies on platform organization and

OCs observe tendencies toward both decentralization and centralization which are leading to unique tensions and dynamics.

Studies that focus on the trend toward decentralization suggest that platforms are distinctive organizational forms which differ from markets, hierarchies, or networks. [Stark and Pais \(2020\)](#) suggest that while markets contract, hierarchies command and networks collaborate, platforms co-opt. Since the term platform is “specific enough to mean something, and vague enough to work across multiple venues for multiple audiences” ([Gillespie, 2010](#), p. 349), it facilitates co-option as a form of distributed rational control distinct from the normative, technical, and bureaucratic control used by experts in the past ([Cameron & Rahman, 2022](#); [Kellogg et al., 2020](#)). For instance, blockchain platforms have enormous growth potential. Through the mobilization of heterogeneous communities of hierarchically independent actors who contribute their expertise to complementary applications the blockchain technology can be programmed to adapt to countless needs and niches beyond those anticipated by its original developers ([Davidson et al., 2018](#); [Lumineau et al., 2021](#); [Notheisen et al., 2017](#); [Zachariadis et al., 2019](#)). This decentralized approach is credited for fostering innovation and enabling a democratic approach to knowledge creation ([Barrett et al., 2016](#); [Shaikh & Vaast, 2016](#); [Tiwana et al., 2010](#); [Von Krogh et al., 2003](#)). [Priharsari and Abedin \(2022\)](#) note that although OCs are often created or managed by organizations, they remain largely autonomous. Even in sponsored communities, enforcing compliance and controlling value creation are difficult and uncertain tasks. These characteristics can be explained by several processes. Fluidity defined as the continuous evolution of rules, participants and interactions, encourages continuous inflows of new ideas and perspectives in OCs while enabling participants to shift roles as their engagement changes ([Faraj et al., 2011](#); [Lyytinen et al., 2016](#); [Priharsari & Abedin, 2022](#); [Safadi et al., 2021](#)). Transparency and openness, foundational to open-source ideology, ensure that code remains visible and accessible to everyone even during the most critical phases of development ([Diriker et al., 2023](#); [Hippel & Krogh, 2003](#); [Shaikh & Vaast, 2016](#)). Trust mechanisms such as swift trust arising from shared goals, shared values and repeated interactions, have been shown to facilitate cooperation, integration, validation, and knowledge sharing in OCs that lack traditional organizational structures ([Ren et al., 2007](#); [Von Krogh et al., 2012](#)). Digital platforms enhance these affordances by providing an infrastructure for fluid and open large-scale collaboration ([Barrett et al., 2016](#); [Constantinides et al., 2018](#); [Diriker et al., 2023](#); [Lyytinen et al., 2016](#)).

At the same time, there is a strand of work that studies centralization practices which allow individuals or subgroups to accumulate disproportionate influence in OCs ([Burrell & Fourcade, 2021](#); [Dorschel, 2022](#); [Pachidi et al., 2021](#)). Centralized expertise can result from the technical complexity of the digital technology ([Crowston & Howison, 2006](#); [Von Krogh et al., 2012](#)). According to [Burrell and Fourcade \(2021\)](#), a coding elite comprised of software developers, computer engineers, and researchers can introduce centralization practices in platform models by retaining exclusive ownership over translation of social norms into computer code either because they are the only actors that understand the code or because they own the code and are able to influence how others deploy it. In platform

organization, coding elites play a crucial role in managing knowledge contributions and maintaining code quality (Dahlander & Frederiksen, 2012; Hippel & Krogh, 2003; Levina & Arriaga, 2014). In line with the open-source ethos, individuals aspiring to become core contributors may volunteer to play informal leadership roles within the community, guiding discussions, validating knowledge, and setting collective norms (Dahlander & O'Mahony, 2011; Howison & Crowston, 2014; Levina & Arriaga, 2014; Stewart & Gosain, 2006; Von Krogh et al., 2012). To become a core contributor typically requires significant time and effort since social status must be earned through proven expertise and continuous contribution. The terms “trusted lieutenants” (Hippel & Krogh, 2003; Shaikh & Vaast, 2016) and “fiduciaries” (Walch, 2019) have been used to highlight the pivotal role of these individuals in the governance and coordination of OCs. However, some studies examine the dark side of this phenomenon. Centralized expertise, although beneficial for maintaining high standards and ensuring continuity, can lead to power imbalances and gatekeeper behaviors which stifle innovation by limiting the diversity of ideas and slowing the incorporation of novel contributions (Crowston & Howison, 2006). This can result in the establishment of elites and power networks that concentrate and obscure decision-making about technology developments (Burrell & Fourcade, 2021; Schübler et al., 2021) and hierarchies which control less powerful and less visible digital actors (e.g., users, gig workers) (Burrell & Fourcade, 2021; Dorschel, 2022). These negative outcomes have become more problematic over recent years with the gradual shift in the contributions of OCs from hobbyist to professional and commercial and more aligned to increased corporate involvement in open source projects (Santos et al., 2013; Shaikh & Vaast, 2016; Von Krogh et al., 2012) and online crowds (Frenken & Fuenfschilling, 2020; Schübler et al., 2021). From such perspectives, control over expertise in the fluid and digitalized capitalistic society resembles traditional forms of expertise.

Advancing the De/centralization Debate: The Role of Emerging Technologies

In sum, the interplay between de/centralization tendencies in OCs is causing unique tensions which may challenge our understanding of expertise. Decentralized expertise has been credited for fostering inclusivity and democratic creation of knowledge but can pose coordination challenges and code quality inconsistencies. Centralized expertise is seen as ensuring high technological standards but also can lead to power imbalances and gatekeeper behaviors which challenge the OC philosophy. Achieving a balance among these tensions is crucial for OC sustainability and success (Dahlander & O'Mahony, 2011; O'Mahony & Ferraro, 2007; Tiwana et al., 2010). Studies such as Safadi et al. (2021), Hemetsberger and Reinhardt (2009), and Dahlander and Frederiksen (2012) explore the origins of valuable contributions in online technological communities and highlight the frictions that emerge between core and peripheral participants. This stream of work finds that both socially embedded (core) participants and epistemically marginal (peripheral) participants contribute highly valued knowledge, and that the interplay between their roles is crucial for effective knowledge production. However, how this interplay unfolds and its consequences for OCs have so far received

limited research attention. The existing literature discusses numerous strategies for balancing de/centralization tendencies. These include boundary objects, that is, tools and structures that provide an interface between the core technology and complementary innovations allowing both stability and integration of diverse contributions (Ghazawneh & Henfridsson, 2010; Hemetsberger & Reinhardt, 2009), adaptive and multifaceted governance schemes that combine elements of autocracy, oligarchy, federation, and meritocracy (Shaikh & Henfridsson, 2017), hybrid open-closed models (Diriker et al., 2023; Hippel & Krogh, 2003), and temporary private spaces or “digital folds” which balance transparency and privacy according to the needs of the development work (Shaikh & Vaast, 2016).

However, although important these studies have some limitations. In contrast to issues such as coordination and motivation, expertise and knowledge distribution have received scant attention in research on OCs with most studies focusing either on the need for centralized expert roles or the ideals of radical knowledge decentralization but not their joint effect. This stream of work also overlooks the role of emergent technologies and the algorithmic processes underlying the structuring of OC knowledge (Bailey et al., 2022; Faraj et al., 2016). Glaser et al. (2021, p. 2) criticize the current views of algorithmic technologies as “precise recipes that specify the exact sequence of steps required to solve a problem” because they tend to minimize or exclude human intervention (Pakarinen & Huising, 2023). However, from a strictly computational and programming perspective, an algorithm implies a set of non-automatic translations from a logic component that defines what needs to be done in abstract terms, to a control component that defines how it should be done (Glaser et al., 2021). Many of these steps are performed by computer programmers, but other actors in and around OCs such as technology researchers, users, investors, auditors, and orchestrators may also shape how algorithms are produced and implemented into code (Alaimo & Kallinikos, 2021; Barrett et al., 2016). According to Faraj et al. (2016), the domestication of increasingly complex digital technologies such as artificial intelligence, blockchain, and big data is shifting the focus from the individual efforts of single contributors, such as coding elites, to the collective social practices that allow entire communities to make sense of new technologies and find a place for them in their daily interactions (Anthony, 2021; Bailey et al., 2022). This changed perspective invites renewed attention to how OC relationships shape de/centralization tendencies via the social production of algorithms. Consequently, in this context, expertise should be studied from both a substantial standpoint – where the expertise is localized and embodied, and from a relational standpoint – how this expertise is constituted and negotiated through social interactions (Alaimo & Kallinikos, 2021; Anthony, 2021; Bailey & Barley, 2020; Dorschel, 2022).

CONTEXT AND METHODS

Context Description

Ethereum is a decentralized open source digital platform founded on blockchain technology. In essence, blockchain is a public ledger which has been likened to a

long DNA chain that grows in size periodically as information about new transactions is added. These transactions are stored in blocks which are linked linearly using cryptographic hash functions allowing each block to be traced back to its genesis block, hence the name “blockchain.” The chain is maintained by a network of nodes which verify the validity of the transactions. These transactions are added to the chain as new blocks based on consensus mechanisms which can assume various forms depending on the blockchain type (Notheisen et al., 2017). In being decentralized, immutable and transparent, blockchain dispenses with intermediaries and centralized authority and serves as a single source of truth, enabling the actors to read and write according to a common database in which all participants can trust (Buterin, 2014; Davidson et al., 2018; Felin & Lakhani, 2018).

Ethereum was co-founded in 2013 by Vitalik Buterin, a Canadian computer programmer who wanted to extend blockchain applications beyond financial payments. Ethereum is the second largest blockchain ecosystem after Bitcoin and is famous for having introduced deployment of smart contracts and decentralized applications to blockchains thereby shifting application domains from financial payments to virtually every sector of the economy (Buterin, 2014). In addition to the baseline protocol, Ethereum hosts over 50 million smart contracts² which constitute the backends for a wide range of decentralized applications that can be created and deployed by anyone with appropriate programming skills. For example, Ethereum provides a platform for decentralized finance (DeFi) applications which provide a broad array of financial services, including borrowing or lending without the need for financial intermediaries such as brokers, exchanges, or banks. It also hosts non-fungible tokens which represent digital ownership of assets and privileges.³ It controls a native cryptocurrency called Ether (ETH) which is ranked second in market capitalization value to Bitcoin. In 2022, ETH’s market capitalization was \$200 billion, 400 times its value in 2016.⁴ The Ethereum ecosystem is home to one of the most vibrant and fastest growing communities in the crypto space and includes core blockchain protocol developers, independent developers of smart contracts and decentralized applications, and the actors that make the blockchain machine “work” by providing the computation resources necessary to verify transactions (i.e., validators, stakers), cryptocurrency holders, investors, and community managers among others.⁵

To understand how expertise is socially constructed and distributed within the Ethereum community, we investigate the perceptions of and interactions among these different actors responsible for keeping alive the Ethereum platform.

Data Collection and Analysis

Data collection occurred between 2020 and 2023 and involved 65 primary source semi-structured interviews and 75 secondary source videos (e.g., online meetings, tutorials, live recordings available on YouTube) and podcasts involving Ethereum community members. Interviewees were identified through a mix of online recruiting and snowball sampling techniques. Initially, contact was made with members of the Ethereum community who were relatively active in the community’s forums and on social media. Interviewees were asked to introduce the

researchers to ecosystem stakeholders whom they knew, and thought could provide interesting insights. In addition, community managers who agreed to participate were asked to host and/or endorse the research project on the community's social media such as Reddit and Discord in order to identify and recruit new interviewees. All interviews were conducted on-line, lasted around 75 minutes on average, and were recorded and transcribed verbatim.

Archival data include 89 documents – reports, white papers and research papers, community members' blog posts, and other documents available on the Ethereum website. During data collection and analysis, the author integrated the data collection process with specific searches for critical incidents in the life of the Ethereum community. These searches used data scraping on some of Ethereum's popular Reddit channels to extract and analyze 618 community posts and 3,889 comments and searched the Lexis Nexis database for media coverage of critical incidents in a total of 430 articles. The data were imported into an integrated database on Dedoose, a web-based platform for computer-assisted qualitative analysis.

Grounded theory (Strauss & Corbin, 1990) was used to shed light on the participation of the Ethereum community in the social negotiation of blockchain expertise, alongside continuous back and forth between the various data sources and extant theory on platform organizing and expertise negotiation. This allowed development of a grounded model of the paradoxes involved in decentralized expertise in platform communities such as Ethereum. The following steps were performed iteratively: (a) open coding of interviews, podcasts, and videos including among other things types of actors and roles involved in Ethereum governance, definitions of knowledge and expertise about blockchain, definitions of expertise, roles and practices in the Ethereum ecosystem and the trust dynamics, incentives and accountability processes in place; (b) open coding of archival data to integrate and triangulate interview information on decision making processes, knowledge, roles and positions, membership, incentives, responsibilities, and accountability; (c) axial coding across data sources to identify sets of recurrent relationships between attitudes to expertise, relationships among expert roles and positions, expertise centralization and decentralization practices, and critical incidents in the life of the community; (d) further data collection and analysis of the critical incidents identified in the life of the community; (e) selective coding to generate a grounded model of the community-level practices involved in establishing a decentralized expertise system. This last step implied going back and forth between steps (c) and (d) that is axial coding of the types of actors in the ecosystem and their expertise, membership, roles, and participation based on two cardinal ecosystem conditions (i.e., routine operation and critical events) that emerged from axial coding of primary and secondary data sources (d). Specifically, as part of the selective coding process (e), I focused on the expertise practices of each type of actor, and categorized them according to whether they referred to centralization and/or decentralization tendencies, and whether they emerged from routine operations and/or during critical events. Subsequently, actors' expert practices were aggregated into two main categories "centralized" or "decentralized" – and were compared using the ecosystem condition criterion (routine operation and critical events). This exercise identified two main tensions

in the data which I labeled “rough consensus and running code” and “wide consensus and better code,” based on ethnographic evidence derived from the interviews and secondary-source videos. This provides a record of the permanent tensions characterizing Ethereum’s efforts to setup a decentralized system of expertise to govern its blockchain technology and shows how the Ethereum community oscillates between the two states that cause these tensions.

FINDINGS

The Decentralization Tensions at Ethereum

The study findings highlight the ongoing tensions in Ethereum’s efforts to establish a decentralized expertise system of blockchain governance. These tensions derive from the simultaneous practice of centralization and decentralization of expertise based on two alternative beliefs within the Ethereum community. Rough consensus and running code reflects the belief that centralizing expertise (and granting decision-making power based on expertise) in a select group of actors (e.g., core developers, researchers) is necessary for routine operations but potentially harmful for long-term survival. Wide consensus, better code encourages expert contributions from the broader community to prevent concentration of expertise (and power) among a few active and knowledgeable members. Wide consensus better code suggests that decentralizing expertise is vital for long-term survival but is difficult or potentially harmful for routine operations. The following interview extract describes this constant state of tension and the contrast between these two perspectives:

How to say this, rough consensus and running code is basically writing high quality code to make sure that Ethereum continues to be one of the most reliable systems out there, while continuing to represent the Ethereum community, or at least those directly interested to contribute ... we could also say wide consensus and better code ... more participation can lead to stronger blockchain technology and avoid centralizing decision-making in the hands of few which is not what we stand for (I12 ETH Core Developer)

Table 1 delves deeper into these tensions by providing a systematization of the centralization and decentralization practices in the ecosystem in the form of a 2×2 matrix. This matrix is based on the nature of the expertise – centralized or decentralized – being mobilized and the ecosystem conditions – routine operation or critical events. It includes four practices that explain how these tensions are managed in blockchains: invisibilizing and individualizing experts, and visibilizing and generalizing collective expertise.

In sum, **Table 1** depicts the delicate balance between individualized accountability and the need for widespread participation which explains how blockchain communities operate and navigate crises in paradoxical yet complementary ways. During routine operations, decentralization practices are more visible. The community seeks collective contributions to “better code” while individual experts such as core protocol developers or researchers operate in the shadows. However, in times of crisis, attention and accountability shift these experts – hence the need to decentralize Ethereum expertise. However, although there is a need for

Table 1. Expert Practices by Condition and Emerging De/centralization Tensions.

| Nature of Expertise | Expert Practices by Condition and Emerging De/centralization Tensions | | |
|---------------------|--|---|--|
| | Routine Operation | Critical Events | Tensions |
| Centralized | <i>Invisibilizing individual expertise:</i> setting up a minimalist technocracy to ensure “running code” | <i>Individualizing:</i> establishing individual accountability for critical incidents | <i>Rough consensus, running code:</i> centralization as necessary for routine operation but potentially harming for long-term survival |
| Decentralized | <i>Visibilizing collective expertise:</i> encouraging wide community contributions to “better code” | <i>Generalizing:</i> calling for collective problem-solving and preventive monitoring | <i>Wide consensus, better code:</i> decentralization as vital for long-term survival but impossible and/or potentially harming for routine operation |

decentralization to balance the risks related to centralization, in crisis situations decentralization practices can prove fragile and may collapse due to misunderstandings about roles and participation which underlines the crucial importance of central experts. In the following sections, I explore these dynamics by showing first how centralization tensions emerge in routine and critical events, and second by examining the related decentralization tensions.

Centralization Tensions: “rough consensus and running code”

During Ethereum routine operations, expertise operates in the shadows. Transactions on Ethereum’s blockchain are automatic and do not require human intervention. However, the system enabling these transactions is supervised and orchestrated by a minimal technocracy to ensure rough consensus and running code. This technical expert elite receives implied legitimacy from a wide base.

Routine Operation: Invisibilizing Individual Expertise

The Ethereum system runs on a network of interconnected computers which each use Ethereum software. The core of this blockchain is Ethereum’s virtual machine (EVM), which is a decentralized computer that executes smart contracts. The EVM ensures that smart contract code runs consistently and predictably, regardless of hardware or software differences across the network. It simplifies the blockchain underlying complexity and provides a uniform platform for running smart contracts, balancing diversity and unity within the network. The role of the EVM in the Ethereum technology and ecosystem is described on Ethereum’s website as follows:

The EVM's physical instantiation can't be described in the same way that one might point to a cloud or an ocean wave, but it does exist as one single entity maintained by thousands of connected computers running an Ethereum client. The Ethereum protocol itself exists solely for the purpose of keeping the continuous, uninterrupted, and immutable operation of this special state machine (ArchD_Doc21).

The Ethereum core protocol is the software engine that ensures the smooth functioning of the EVM. Regular updates to this protocol are essential to avoid problems and manage the impact on the ecosystem's applications. However, the decentralized and open-source nature of Ethereum means that carrying out these updates is not straightforward. Since there is no single entity that controls Ethereum, all changes must be agreed among the network participants. Protocol upgrades are introduced as new software versions which the network nodes (validators) can choose to adopt or not. An update that does not gain enough support will likely not be implemented. The stakes are high since flawed code could disrupt the entire system and cause significant financial and reputational damage. It is thus crucial that protocol upgrades are of the highest quality.

In theory, no single individual or company governs the development of the Ethereum core protocol; although upgrades can be proposed by a single entity, these subsequently are peer-reviewed by the community. However, in practice in blockchain ecosystems such as Bitcoin and Ethereum, key decisions are made by technical experts such as protocol developers, programmers, and researchers.

Table 2 presents the actors in the Ethereum ecosystem in relation to the de/centralization tensions; core developers and researchers constitute centralization patterns and software developers and programmers (dApp developers), validators, and cryptocurrency holders provide decentralized contributions. The Ethereum Foundation acts as an ecosystem orchestrator, promoting both stable governance and decentralized participation. Below I describe these actors' expertise, membership, participation, and role in the governance of Ethereum which produce centralizing forces in the Ethereum ecosystem.

Core developers: protocol custody. In the Ethereum ecosystem, an amorphous group of "core developers" (i.e., technology experts very active in the community) influence the direction of the technology through protocol custodianship which involves a mix of technocratic control and open peer-to-peer consultation. The Ethereum improvement proposal process allows anyone to suggest changes to the protocol. These proposals, which might provide enhancements or fixes, undergo thorough review and discussion by the core developers, researchers, and other stakeholders within the community. Core developers act as gatekeepers who conduct informal reviews before formal submissions to ensure proposals meet review standards. They have significant influence over final decisions and are responsible for assessing the impact on the protocol's health. They also play a prominent role in persuading the community about the benefits of any proposed changes.

Some core-developers are permanent employees of Ethereum, others have occasional or part-time collaboration contracts, rely on scholarship schemes, or work for organizations providing applications or infrastructure to the Ethereum ecosystem. It is interesting that the identity and composition of the core-developer teams is unknown. In the interviews, Ethereum members explained that the very

Table 2. Types of Actors Involved in the Ethereum Community and Their Contribution to Ethereum's Organization as a Decentralized Platform.

| Ecosystem Stakeholders | Core Developers | Researchers | Ethereum Foundation | D'app Developers | Stakers | Crypto holders & Community |
|------------------------|--|---|--|--|--|--|
| Expertise tensions | <i>Decentralization</i> | | | | | |
| Type of expertise | Protocol custody | Crypto economic advancements & ecosystem design | Ecosystem development & decentralization | Application ecosystem generation | Cryptoeconomic validation | Cryptoeconomic performance |
| Organizational role | Minimalist digital technocracy ensuring "running code" | Research elite advising/consulting about ecosystem future development based on esoteric knowledge (crypto economics) | Minimalist bureaucratic organization aiming at ecosystem support & decentralization; aims to reduce role/disappear with time | Broad community of complementors (developers of applications on top of the core protocol) contributing to ecosystem growth & diversification | Computation "engine" for transactions and consensus validation (i.e., blockchain transactions) | Critical mass of participants in the functioning of a decentralized ecosystem (crypto market capitalists) |
| Membership | Amorphous group of algorithmic experts with opaque criteria for access | Small group of experts (e.g., researchers) recruited/coopted based on reputation (academic credentials, affiliations, etc.) | Amorphous group of support staff & community developers with opaque criteria for access | Broad and heterogeneous community with open access and almost no form of organization | Broad and heterogeneous community with limited organization (community developers, discussion forums, social media groups, etc.) | Heterogeneous stakeholders keeping the system alive thanks to cryptographic and economic participation to the life of Ethereum – open access to cryptocurrency markets |

(Continued)

Table 2. (Continued)

| Ecosystem Stakeholders | Core Developers | Researchers | Ethereum Foundation | D'app Developers | Stakers | Crypto holders & Community |
|--------------------------|---|--|--|--|--|--|
| Expertise tensions | <i>Decentralization</i> | | | | | |
| Governance | <i>Routine operation:</i> structure decision making as semi-formal processes (EIPs) & act as gatekeepers in protocol update & development <i>Critical events:</i> guide ecosystem decision through opinion making & proposed technical changes | <i>Routine operation:</i> develop reports & inform community about future developments of ecosystem functions <i>Critical events:</i> provide advice about important protocol updates & ecosystem changes | Ensure multi-stakeholder coordination and collaboration for important decisions both during ordinary practice and critical events; intention to disappear in the future to further foster decentralized governance | Limited role in ecosystem governance; can become the spotlight during critical incidents | Critical role both in routine operation & critical events; must validate any significant change of the protocol by accepting to update their software (i.e., protocol version) to proposed changes | Online voting and limited mechanisms of decision making; indirect pressure through crypto market behavior |
| Participation incentives | Ensure “running code” and “better code” thanks to community funding & compensation schemes (e.g., stipends, scholarships via Ethereum Foundation) | Funded by community to advise and provide scientific opinions about future economic development | Ambiguous participation incentives (i.e., ideology, reputation, community funding) | Economic remuneration based on degree of d'app adoption by the community | Capitalistic interests and incentives (maximizing earnings on staked capital) & ideology of blockchain-driven decentralization | Capitalistic interests and incentives (maximizing earnings on cryptocurrency) & ideology of blockchain-driven decentralization |

concept of core developer refers to a position of prestige related to competence and expertise rather than a formal organizational role. Consequently, there is neither a fixed number of core developers nor a typical core developer profile.

Am I a core dev? I don't know (laughing) I guess I am because people say I am. So, in strict terms, a core developer is someone working on the baseline protocol, it's a very technical role. But actually, it's often more than that. There are people like (names of reputed members of the community) who are considered core devs although they lack the technical skills but are so involved and influential that when they speak a lot of guys shut up (...) I guess what really matters is how involved you are with protocol changes and how much you know Ethereum inside out. (I33, ETH Core Dev and Ex-Community Builder)

Researchers: crypto-economic advancements and ecosystem design. Ethereum also uses scholarship schemes to sponsor researchers to work on the development of new algorithms or specifications for core protocol code. These researchers are chosen based on their academic credentials and affiliations. They produce reports and provide recommendations for the community on ecosystem developments and are involved in discussions about proposed changes. Their disciplinary expertise is in cryptoeconomics, an interdisciplinary field that exploits ideas and concepts from economics, game theory, mathematics, and peer-to-peer cryptography to theorize about digital decentralized systems. According to one of our interviewees, in the Ethereum community, they are considered “very reputed assets with unique skills (...) invaluable to the future of the community,” and active efforts are made to coopt and maintain their activity in the community. In contrast to the anonymity surrounding core developers, these researchers are listed on the Ethereum website.

Debate about the need for overseers to ensure protocol changes are safe and reliable is ongoing. Even though researchers and core developers do not confirm to Ethereum's decentralization ethos, these actors are seen as crucial to ensure technology reliability and ecosystem advancement:

Am I happy that there are a bunch of dudes writing code which could potentially have an impact on everything I do here? No, because this is what centralized systems do, what if they mess up, we all bear the consequences, right? But when this thought comes to my mind I ask myself: Would I be able to write it in their place? No, sir, no (laughing). Would most of the folks that stake on Ethereum be able to do it? No, of course they wouldn't (laughing). So if I don't write it, you don't write it, and they don't write it either, what happens to this big dream we all have called Ethereum? (I13 ETH Community Builder)

During normal operations, the expertise of researchers and core developers is invisibilized. They tend not to figure in Ethereum community discussions, and many members are not clear about what they do. Nevertheless, since these experts are vital to Ethereum's operations, community members are willing to trust and respect them. The interviewees said that “they seem to know what they are doing,” and “other people agree about that as well”:

These guys are not just making things up. It takes a lot of knowledge to be able to propose a protocol change to Ethereum, Vitalik, the researchers, the core devs team (...) we wouldn't even be close to where we are without them. To be honest, I understand like 10% of what these guys are saying, maybe less, and I'm sure I'm not the only one (...) It's not ideal to have changes implemented by a limited group of people but what's the option today? (...) I trust Vitalik,

I trust the other guys because they've proven to care about Ethereum more than their self-interests. (I7 ETH Community Builder)

The above extract further exemplifies the centralization of expertise in Ethereum. On the one hand, community members recognize the importance of decentralized expertise, referring to it as the “ideal” condition. On the other hand, they recognize the need for a small group of highly knowledgeable individuals such as Vitalik Buterin and core developers on whom they can rely and whom they consider are dedicated to Ethereum’s interests.

Making Sense of Critical Events: Individualizing Core Expertise

While expertise works in the shadows during routine operations, it comes to the surface and captures the attention of the community. Hacks and thefts, controversial protocol changes, cryptocurrency market volatility, and external pressures from legislators represent typical examples of blockchain crises which cause uncertainty about the ecosystem’s future. In trying to make sense of a crisis and in acting to secure their interests, community members give visibility to the role of experts seeking for both solutions and someone to blame. In turn, by questioning aspects such as core-developers’ ethics or competence, the Ethereum community is questioning the idea of rough consensus and running code. The Ethereum 2016 DAO Hack provides a useful example of these practices.

In 2016, one year after the official launch of the first version of Ethereum’s blockchain, the ecosystem enthusiastically welcomed one of the first experiments of decentralized autonomous organizing (DAO) and one of the largest ever crowdfunding initiatives which in just 28 days raised around \$250 million (Mehar et al., 2019). The DAO project was groundbreaking and allowed people to invest in Ethereum-based startups through a decentralized organization governed by smart contracts. However, shortly after its launch, it suffered a major hack by an anonymous hacker who by exploiting a bug in the DAO smart contract code stole over \$50 million (3.6 million ETH) from the DAO asset pool (Mehar et al., 2019). This incident caused widespread panic and uncertainty within the Ethereum community and sparked a broader conversation about expertise. Since several reputable members of Ethereum’s core team, including Vitalik Buterin, had been involved in supporting or auditing the DAO project, the community held the DAO developers as well as the broader community of Ethereum researchers and developers responsible for having failed in their role of custodians. Discussions on Ethereum’s Reddit channel highlight how critical events visibilize failings and mistakes of experts and encourage the community to call for expertise to be better diffused across the ecosystem:

My question is, how much black hat testing was done on DAO code beforehand? Given the vulnerabilities discovered at the last minute, and this morning’s attack, I wonder if there was too much Utopian thinking behind the project and not enough Devil’s advocates recruited to bang on it. (C1786 r/TheDao)

The DAO hack had a dual effect on expertise de/centralization practices. On the one hand, it reinforced the need for collective vigilance of malicious events

and, thus, greater decentralization of expertise within the Ethereum ecosystem as discussed in the next section. On the other hand, it gave more power to Ethereum experts. Many community members demanded to have their money back and by asking the Ethereum experts involved in the DAO project to find a way to retrieve the stolen funds further increased their power and visibility. Some influential members of the Ethereum community such as core developers and researchers responded by proposing that the state of the Ethereum blockchain should be changed by implementing a fork which would work to reverse the system to the moment before the hack, thus nullifying the hack. Following heated debate between those who favored the intervention strategy and those who considered it incompatible with blockchain's decentralized ideology, a split occurred within the Ethereum community leading to different versions of the protocol and two separate ecosystems (Ungureanu et al., 2025). There were multiple reasons for the split but the most influential was the disagreement over the role of experts and their jurisdiction in a decentralized system (Mehar et al., 2019).

In addition to other major critical events and internal conflicts in Ethereum, threats posed by crypto volatility, continuous malicious attacks, and scams offered periodic opportunities for heated debate within the community on the role of expertise in Ethereum. The argument reached a crescendo in May 2024 when two of Ethereum stars were accused of receiving a multimillion-dollar token incentive package from a pioneering restaking protocol flagged as possibly posing a systemic risk to Ethereum (Nijkerk, 2024). In such critical moments, some experts such as core developers and researchers are made scapegoats, and others become guides about how to escape the crisis and preserve the ecosystem's integrity. Interviewees referred to their "acting as white hats fighting malicious attacks and staying vigilant" and "giving hope about the future of crypto even in crypto's darkest hours" (informants' words). For these reasons, critical incidents put the spotlight on individualized expertise in blockchain ecosystems.

Decentralization Tendencies: Wide Involvement, Better Code

While according to our interviewees the existence of expert roles is considered a "necessary harm for solid operation" it is also widely regarded as a transient situation, a "transition stage towards a system that draws closer to perfect decentralization." The belief in wide consensus, better code exemplifies Ethereum's attachment to the ideology of radical decentralization.

Although public awareness of the blockchain technology began only in 2008 through the introduction of Satoshi Nakamoto's cryptocurrency Bitcoin, it originated in the 1990s with the cypherpunk movement. This was a loosely-knit group of individuals with a shared interest in cryptography, computer science, and libertarian or socialist ideology. The group believed that advancements in cryptography and related technologies could empower individuals and promote social and political change by enhancing privacy, security, and freedom of expression in the digital world. In line with the crypto-anarchist imprinting of the blockchain movement (Swartz, 2018), Vitalik Buterin proposed Ethereum as a decentralized, incorruptible, and transparent technology capable of facilitating a wide range of

transactions between individuals without the intermediation of third parties that would give rise to a new social order (Buterin, 2014; Wood, 2014). The following sub-sections illustrate how the decentralization ideal of wide consensus, better code is supported by a great part of the Ethereum ecosystem during routine operations but falls short when put to the test by a critical event.

Routine Operation: Visibilizing Collective Expertise

In line with cypherpunk ideology, maintaining expertise decentralization is deemed vital for long-term survival but impossible and/or potentially harmful to routine operations. This tension emerged with Ethereum's continuous efforts to visibilize collective community expertise during routine operations but reliance on a small group and limited participation of the community to solve problems related to critical events. Table 2 shows that several actors contributed to the decentralization of blockchain expertise, maintaining a balance with the centralized roles and practices emphasized in the section above. These actors are stakers responsible for cryptoeconomic validation, developers generating Ethereum's vibrant ecosystem of decentralized applications, and cryptocurrency holders responsible for Ethereum's market performance. The following sub-sections illustrate how these actors swing the de/centralization pendulum during routine operation and moments of crisis.

Stakers: cryptoeconomic validation. In addition to being negatively connoted from an ideological standpoint, centralization is a condition feared by blockchain communities because of its association with technology failure. A 51% attack or a majority attack occurs when a single entity or group controls over 50% of the blockchain's computing power which grants them significant domination over the network. This dominance enables transactions to be manipulated and reordered and can allow some rewriting of parts of the blockchain. To avoid this, transactions must be validated by consensus among multiple independent computer nodes.

As already described, blockchain communities include actors who make the blockchain machine "work" by providing computational resources to verify transactions. In Ethereum, these validators are referred to as stakers because they lock up their cryptocurrency as a kind of security deposit which they then can use to validate transactions and create new blocks in the blockchain. In return, they earn rewards in the form of additional cryptocurrency. Although these actors mostly do not have the expert skills required to participate in blockchain development, their actions are vital for any advancements to Ethereum (see Table 2). First, validators can boycott any protocol change proposed by experts simply by refusing to upgrade their software; second, they represent one of the most popular threats in blockchain, the 51% attack. Consequently, most of the cryptographic and game-theoretical advancements in Ethereum proposed by experts are aimed at incentivizing validators to act virtuously and disincentivizing them from performing malicious attacks on the network. Increased decentralization is seen as the best way to prevent 51% attacks:

I think that most of these people are concerned with how much money they're making, or how much money they have to lose, rather than what the long-term consequences for Ethereum will be. So, it's important to have the right economic model in place, both in terms of incentives and sanctions, I don't know if we're there yet but we are working on it (...). (125 Community Builder, ETH Foundation)

A 51% attack requires malicious collusion among validators. However, as explained in the excerpt below, community members also referred to the possibility that core developers and researchers might intentionally introduce vulnerabilities potentially facilitating a 51% attack:

I'm not saying that core devs and researchers are going to willingly blow Ethereum up by creating cracks for a 51% attack, I mean, from day one people like Vitalik, like (names of other reputed members of the community) are doing research on how to avoid this from ever happening, I'm just saying that we all know that centralization is bad for decentralized systems, it's just the way it is, any point of centralization is theoretically a vulnerability that someone, someday, somehow, is going to take advantage of (133 ETH Staker).

As can be seen in the excerpt above, the term 51% attack is used by the community to refer to a wide range of centralization threats involving actors of the ecosystem. It constitutes a collective point of reference because it reminds the community about the importance of preventive actions such as collective vigilance and decentralization.

Ethereum Foundation: ecosystem development and decentralization: To deal with the decentralization threat, the Ethereum community works continuously to visibilize the expertise within the community. This implies encouraging expert contributions from the broad community to ensure perspectives that are diversified beyond those of expert members such as researchers or core developers. These efforts are supported by the Ethereum Foundation, a non-profit organization dedicated to financing and supporting research, development, and real-world application of Ethereum and related technologies. The Ethereum Foundation works to ensure diversity at both the core protocol level and at the application layer level.

In the case of the core protocol, to make the network stronger and more diverse, Ethereum maintains multiple open-source execution clients developed by multiple client teams using different programming languages. The Ethereum Foundation runs a fund dedicated to client teams and scholarships for researchers to work on decentralization advancements. The Ethereum Foundation contributes to ecosystem development more generally by funding or employing community builders who organize calls, competitions, and social media debates to incentivize active participation in the development of the ecosystem (see [Table 2](#)).

However, the Ethereum Foundation also represents a centralization risk. In response to this, the stated aim of the community builders and managers employed by the Ethereum Foundation is to “cease to exist one day, or at least to minimize our involvement in the community as much as possible, in the hope that alternative arrangements for stabilizing sources of expertise will emerge as we make Ethereum more decentralized” (110 ETHF). For this reason, the Ethereum Foundation limits its intervention to “only the essential or else unavoidable forms

of support, such as funding the vital development of blockchain expertise and taking care of administrative and legal issues” (I15 ETHF). Several interviewees from the Ethereum community acknowledged the inherent de/centralization tensions surrounding the Ethereum Foundation:

My sense is that the guys from the Ethereum Foundation are doing a really great job, and a necessary one too, you know? But it's like I said, even if they are, they should disappear in some years' time and leave it all in the hands of the community (...) don't get me wrong, I'm sure they're doing a better job than most of us would, but it's just not safe on the long run. This is not just something I say, they've also been publicly claiming it for some years now, they will have to disappear (...) finding a healthy balance is hard. (I7 ETH Community Builder)

dApp developers: generating the application ecosystem. In addition to core developers and researchers, blockchain expertise usually involves developers who build smart contracts and decentralized applications (i.e., dApps) on top of the core protocol. Since smart contracts execute automatically on the blockchain, how developers write smart contracts code is pivotal, and whether other experts and non-experts trust or can verify their work has a significant impact on the functioning of the entire ecosystem (Buterin, 2014; Davidson et al., 2018; Notheisen et al., 2017). In contrast to core developers, application developers are a much broader and more amorphous group of individuals who often develop applications for multiple blockchain ecosystems. While some consider them “the pulsating heart of the ecosystem” where “decentralized magic really happens” (informants' words), they are also considered less reliable and less concerned about the future of the Ethereum ecosystem compared to researchers, core developers, and the Ethereum Foundation. For instance, an Ethereum staker described dApp developers as utilitarian complementors of blockchain ecosystems rather than members of the Ethereum community with a common purpose and identity:

What these people want is to make money, as long as Ethereum allows it they will continue to bring their work here and make the system grow but as soon as something goes wrong or this platform becomes less profitable, they're gone and they won't be looking back. (I40 ETH Staker)

One core developer interviewee said that core developers sometimes scrutinize or even question dApp developers' expertise and suggested that their work might be intentionally malicious or poorly executed:

There are so many dApps out there and so many different people working on them that it's really hard to tell, I mean, some of them are scams and some of them are legit but with so little transparency the line is thin ... take into consideration that in most of these apps we never get to know who the developer was ... Many times, it's really hard to trust a project, or to actually understand if it's any good (...) What to do about it? If you read it you can clearly understand if the code is any good and the guy has any idea what he's doing (...) but not so many actually do it or, I don't know, I mean, I do it but I'm a core dev, not an average user. (I18, ETH Core Developer)

These interview extracts show that application developers within the Ethereum community may be scrutinized over their ethical integrity and code writing ability. The increasing number of community members with no programming expertise makes concerns over scams and frauds more prominent and exacerbates the

tensions between centralized and decentralized forms of monitoring of blockchain applications development. While some are in favor of trusting experts to oversee decentralized application development and identify fraudulent projects, there is a lack of consensus within the community about who should be responsible for setting and enforcing rules and standards.

Crypto holders and the broader community: cryptoeconomic performance. The interview extract cited above makes it clear that the Ethereum ecosystem also includes cryptocurrency holders and other members of the broader community. The cryptographic and economic participation of these heterogeneous stakeholders in the life of Ethereum keeps the Ethereum system alive. Although their participation in the governance of the ecosystem is limited to voting and coordination during critical events, their mobilization of capitalistic interests and incentives to maximize their earnings continuously shape the performance of Ethereum in the cryptocurrency markets which in their turn condition routine organization of the ecosystem. The attempts of the community builders of the Ethereum Foundation to increase decentralized expertise involve encouraging the active participation of the wide Ethereum base, especially in important decisions and vigilance toward potential malicious attacks. For example, as shown in the excerpt below, a group of community builders produced a series of YouTube videos to encourage the building of a strong and participatory community of Ethereum stakers around the need to fight malicious attacks:

We do these podcasts for a reason, and this is to tell you, folks, study before investing, go and see who the guy is, talk to other people in the community to understand if it's legit, ask me or [name of other community builder], write it on our forum and people will step in and give you valuable feedback, we say this all the time, get involved, stay vigilant, don't just throw your money away. (ArchD_YouTube Video 4, ETH Staking Community Builders)

This excerpt shows how community builders either independently or with the support of the Ethereum Foundation try to foster a decentralized approach to blockchain expertise, by promoting collective vigilance against malicious attacks and fostering a culture of peer reviews. The excerpt shows that this can be achieved through communications aimed at educating the wider community and providing information about possible dangers and pitfalls.

In sum, [Table 2](#) shows that the roles of the actors in the Ethereum ecosystem can be distinguished based on their attitude to the de/centralization tensions, with core developers and researchers representing centralization, and decentralized contributions coming from dApp developers, validators, and cryptocurrency holders, and the Ethereum Foundation acting as an untraditional ecosystem orchestrator that contributes to both centralization and decentralization practices.

Making Sense of Critical Events: Generalizing Collective Expertise

Although decentralization is often seen by the community as the best means to ensure long-term healthy development of the Ethereum ecosystem, critical incidents highlight the difficulties involved in implementing decentralization in routine operations. For instance, during the critical DAO hack incident, calls for

increased decentralization were confounded by the community's very limited understanding of and participation in technical decision-making during a crisis. The Ethereum community was faced with a 28-day window in which to decide whether to fork the blockchain, negate the hack, and restore the stolen funds which resulted in the decision being put to the vote. Since a significant number of community members did not vote, whether the decision to fork truly reflected what the community wanted is unclear (Ungureanu et al., 2025).

The following extracts highlight the challenges related to generalizing expertise within large and heterogeneous ecosystems such as Ethereum. A core-developer who formerly developed decentralized finance applications illustrates the de/centralization tensions in critical incidents. The crowd blames experts for system failures while experts blame the crowd for its failure to exercise the rights and responsibilities of a decentralized organization:

I started working as a developer in de-fi (decentralized finance) but I stopped as soon as I could because it was terrible (...) People coming at you all the time blaming you for losing money, it was terrible, sometimes I could not sleep at night because of the terrible messages I received (...) People are ignorant, they place their money in crypto projects they know nothing about and then take it out on the programmer. They don't understand that there is a market out there and you lose or win money because of how the project performs on the market, not because of how I wrote the code (...) security is also often brought up but sometimes people just don't know how to take care of their keys, if they get hacked they immediately blame it on the project's code vulnerability and not on their stupidity (...) In general, everyone in Ethereum wants decentralization but it is easy to forget that for decentralization to work everyone must participate, you can't just delegate when it's profitable and claim your rights when it's not. (I48, ETH Core Dev)

The above extract indicates that lack of expertise and irrational investment behaviors within blockchain communities are factors that contribute significantly to the occurrence of scams and hacks. Ethereum experts and community builders attribute this to the hype surrounding crypto investments, and the many individuals who invest in these projects without understanding the technology and the associated risks. This suggests that extending blockchain expertise to the broader community base would not be feasible.

Other critical events involving scams and fraud provide further examples of this issue. For instance, ERC-20 tokens are digital currencies built on the Ethereum blockchain, adhering to a standard set of rules for compatibility across applications. These popular tokens have been targets of countless phishing attacks, leading to continuous crypto losses. Scams exploit vulnerabilities in smart contracts and user authentication processes, often through use of fake websites or emails to trick users into revealing private keys or transferring tokens to malicious actors. Every attack sparks more debate over the responsibility of experts to guard against technology flaws versus the responsibility of the community to be better informed. A core developer said that although flaws exist in the design of ERC-20 tokens, the increased number of scams is due mainly to manipulation tactics used to trick users who interact with security systems rather than to inherent flaws in the technology.

The standard itself is flawed (...) Unfortunately, we can't require all of the [wallets] to do things in the right way, especially if the community can't agree on what is the right way. (ETH Core Dev in Yun, 2024)

However, community members blame core developers for not considering scams a high-priority issue and call for experts able to monitor, audit, and prevent faulty or malicious technologies, this way swinging the pendulum back to centralization.

In sum, critical events such as hacks, scams, and major changes highlight the conflicting role of expertise. On the one side, core developers and researchers are blamed for failures, prompting calls for more decentralization; on the other side, given the challenging task of spreading blockchain expertise to the large community, they also become the only solution to crises, or as one interviewee put it an “unavoidable harm, at least for the moment.” Thus, critical events highlight the risks and advantages of centralizing knowledge and decisions in the hands of a few capable individuals. While interventionism is necessary for short-term routine operations, the community would prefer a future Ethereum with broader participation where as one interviewee described it “many knowledgeable people participate and (...) the power belongs to all but nobody, ever really gets to hold the scepter.”

DISCUSSION

This study adds to our understanding of expertise organization in emerging digital technologies that require decentralized forms of organization. Several studies refer to the changing nature of work in the digitalized world (Bailey et al., 2022; Dorschel, 2022; Faraj et al., 2018; Pachidi et al., 2021) and the problems that arise from the use of algorithms (Burrell & Fourcade, 2021; Kellogg et al., 2020; Susskind & Susskind, 2015). The present study sheds light on the role of experts in decentralized systems such as blockchains and other digital platforms.

This research adds to the growing literature on open online communities, and in particular to work on the governance-knowledge organization nexus (Dahlander & Frederiksen, 2012; Faraj et al., 2011, 2016; Howison & Crowston, 2014; Safadi et al., 2021; Shaikh & Vaast, 2016; Von Krogh et al., 2003; Yoo et al., 2012). While blockchain has been considered a novel and disruptive technology, the present study shows that the social organization underlying blockchain technological platforms has many similarities to other OCs such as open source software (Fitzgerald, 2006; Hippel & Krogh, 2003; Shaikh & Vaast, 2016; Von Krogh et al., 2012) and open innovation (Faraj et al., 2011; Lyytinen et al., 2016; Yoo et al., 2012). This work offers an empirical examination of two blockchain theses “rough consensus and running code” which highlights centralization tendencies, and “wide consensus, better code” which highlights decentralization efforts in blockchain OCs. It was here shown that the Ethereum blockchain community engages simultaneously in expertise centralization and expertise decentralization practices. This requires a delicate balance between individualized accountability and the need for widespread participation to enable the community to navigate both routine and critical moments in paradoxical but complementary ways. Four practices explain how de/centralization tensions are managed in blockchains. During routine operation, collective expertise is visibilized while individual expertise operates in the shadows; crises reveal the

blame and responsibilities assigned to individual experts and highlight the need for more decentralization of expertise. Decentralization practices emerge as a reaction to centralization risks and are aimed at distributing expertise more widely within the Ethereum community but can collapse during crises which then require intervention of centralized experts.

The findings contribute to the literature on knowledge governance practices in OCs such as temporal bracketing, digital folds and hybrid open-closed models (Faraj et al., 2016; Safadi et al., 2021; Shaikh & Vaast, 2016). The literature suggests that open source development relies on ongoing collective coordination and governance overseen by elite developers. Many individuals may contribute sporadically but the elite plays a crucial role by providing content regularly, intervening in emergencies and safeguarding community boundaries by means of temporary closures and measures imposed to enable prompt address of critical issues. This study has highlighted the importance of critical events that punctuate routine operations in a decentralized system and suggests that de/centralization tensions can be examined fully only at their interface.

However, critical events in decentralized systems such as blockchains may have different consequences from those theorized in the OC literature.

Specifically, decentralized algorithmic technologies such as blockchain may significantly reduce the ability of elites to enact efficient bracketing practices and closure moments, fostering continuous de/centralization tensions and debates within the community. First, given the decentralized functioning of blockchain technology and the distributed nature of its consensus mechanisms, trust in experts is displaced from the transactions level (i.e., exchanges occurring on cryptography-governed platforms without third party intermediation) to the socio-technical system that enables these transactions. This involves the researchers and developers who write and audit the code through a peer-review process, and the validators who make the blockchain machine work, the holders of tokens and cryptocurrencies contributing to the growth of the ecosystem's market value, and the community builders advocating for these stakeholders' interests and organizing them into factions and coalitions. This organization differs from both more traditional organizational forms where roles and responsibilities are clearly assigned to expert participants who compete for jurisdictional power, and also from more traditional open software communities where experts are often the majority who possess the technical knowledge.

Second, as the result of blockchain hybrid ideological underpinnings, blockchain communities are shaped by constant interplay between the capitalistic goals of utility maximization, neoliberal and anarchist ideologies of decentralization, and technocratic theories of cryptoeconomic decentralization (Jacobetty & Orton-Johnson, 2022). The eclectic mix of aspirations in the Ethereum community depends on reliable technology which in turn is associated with ecosystem stability and financial performance. The community generally accepts that technology experts step in and take the lead to ensure economic and technological stability. In their turn, technology experts accept the community's investment in exchange for social status and financial incentives. However, this tacit

social contract is fragile. As soon as a critical incident occurs, the roles of experts become objects of heated public debate and their ability of experts to impose control and closure mechanisms is constrained by the mix of technocratic, economic, and ideological interests which characterize Ethereum and amplify debates about de/centralization in the event of a crisis (Ungureanu et al., 2025).

It should be noted that system decentralization is a key concern for all the actors in the blockchain ecosystem including “elites.” In his cypherpunk manifesto, Hughes (1993) describes how a blockchain system which tends toward centralization is vulnerable to failure and thus is less likely to attract and reward social, technical, and economic capital. In this view, technical failure is also likely to lead to social and economic devaluation (Davidson et al., 2018). The paradox in this is that experts holding central positions may sacrifice their reputation and ability for the sake of a better more reliable technology. From such standpoint, the value of blockchain expertise lies not so much in the ability to write the code, as in the ability to collaborate with others to write code to achieve a healthy decentralized system. For instance, although Ethereum researchers have centralized power, their mission is to identify and eliminate failure points in the system potentially caused by any type of centralization threat including expertise. Some experts recognize that they are a centralization threat and promise that in the long terms they will cease to exist for the sake of Ethereum. These evidence suggest that differently from what may happen in other open software communities, in blockchains both experts and other community members (validators, community builders, cryptocurrency owners) occupy liminal roles in the continuous struggle between de/centralization forces because of the cryptoeconomic underpinnings of blockchains – that is, the unique mix of technological, algorithmic, and economic needs and requirements. Thus, although openness and decentralization are core values for most OCs (Krishnamurthy et al., 2016; Stewart & Gosain, 2006; Von Krogh et al., 2012), in blockchains de/centralized expertise is a consequence of relational negotiations following a quasi-free market logic.

In sum, the fluid nature of blockchain communities and the wide diffusion of technical, capitalistic, and anarchist ideologies across different categories of stakeholders, mobilize and sustain the de/centralization tensions identified in this paper. Overall, these conditions call for renewed attention to the liminal role of expertise in decentralized systems. In the context of an increasingly digitalized, decentralized, and connected world where systems of expertise become progressive sociotechnical entanglements of material and non-material actants such as people debating models, cleaning training data, designing algorithms, tuning parameters, deciding on context conditions, reviewing and revising code and adapting it to constantly changing situations (Alaimo & Kallinikos, 2021; Anthony, 2021; Anthony et al., 2023; Bailey et al., 2022; Glaser et al., 2021), we also need to inquire about how expertise is socially constructed in such systems, if and how experts self-affirm and/or are recognized, legitimated and made responsible (Kolkman, 2022). The present study was intended as a first step in this fertile research field and a call for more research in this direction.

NOTES

1. The OpenAI manifesto states that: “Our mission is to ensure that artificial general intelligence benefits all of humanity. We are building safe and beneficial AGI but will also consider our mission fulfilled if our work aids others to achieve this outcome” (<https://openai.com/about/>).
2. https://dune.com/sawmon_and_natalie/smart-contracts-on-ethereum
3. <https://coinmarketcap.com/currencies/ethereum/>
4. <https://www.globaldata.com/data-insights/financial-services/ethereums-market-capitalization-history/>
5. <https://ethereum.org/en/community>

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