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Trust in blockchain-based systems

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Keywords: Trust, Blockchain

Abstract: Trust can best be understood as a relational attribute between (1) a social actor and other actor(s) (interpersonal trust) and / or (2) actors and institutions (institutional or systemic trust) and (3) institutions and (trusting) actors (trust as shared expectations), where institutional frameworks define the nature and strength of trust relationships between different actors.

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Definition

Trust can best be understood as a relational attribute between (1) a social actor and other actor(s) (*interpersonal trust*) and / or (2) actors and institutions (*institutional* or *systemic trust*) and (3) institutions and (trusting) actors (*trust as shared expectations*), where institutional frameworks define the nature and strength of trust relationships between different actors.

Conceptual background

The notion of *trust* is of key significance, with a broad literature spanning from social sciences via law to computer science (Blöbaum, 2016; Bodó, 2020; Botsman, 2017; (Clarke et al., 2006), 2006; Fukuyama, 1995; Gambetta, 1988; Giddens, 1990; Hardin, 2002; Luhmann, 2017; McKnight et al., 2011; Putnam, 2001; Schneier, 2012; Sztompka, 1999). This leads to substantial confusions when it comes to discussing trust in the context of digital technologies in general, and in the case of distributed technologies in particular (Baldwin, 2018; Bellini et al., 2020; Dingle, 2018; Jacobs, 2020; Werbach, 2018a). We do not try to represent all aspects of these different disciplinary discussions, instead, we used a simplified model of trust adapted from the work of McKnight et al. (2011) to give a basic overview, point out the most relevant issues, and provide a working definition of trust in the context of blockchain and other distributed techno-social systems.

Trust relationships always involve a number of actors: (1) a trustor, with his or her individual attitudes, trusting beliefs, stands towards trusting, and "generalized faith in humanity", (2) a trustee, that can be an individual, in which case we talk about interpersonal trust (Hardin, 2002), or an institution, the government, or a profession, in which case we talk about institutional, or systemic trust (Giddens, 1990). Trust is the instrument with which the trustor manages the contingencies that relate to trusting the trustee to act competently, in the interest of the trustor in concrete given contexts.

The emergence of trust has three prerequisites. First, it depends on the attitudes, beliefs of the trustor. Second, it is a factor of the (perceived) trustworthiness of the trustee: its past actions, reputation, objectively verifiable, or faith based qualities to be competent, benevolent, and maintain integrity (Mayer et al., 1995). Third,

both sides are embedded in wider, institutional environments, which create shared knowledge, a shared understanding of general, and context specific rules of the game (Shapiro, 1987; Zucker, 1985), and which can provide structural assurances on the behaviour of the trustee for the trustor. These latter include legal instruments, such as laws (Balkin, 2016; Hall, 2002), contracts (Foorman, 1997), government regulatory and oversight bodies, professional codes of conduct, governance and quality assurance, or market-based functions, such as insurance against risk.

Trust and distributed technologies

Within the context of trust and distributed technologies, therefore, the question of trust can have many dimensions. If the role of the distributed techno-social system is to connect people, if it allows, or relies on the collaboration of individuals, in the interpersonal trust dimension, the question is how can we (or: do we need to) trust the (often anonymous) stranger with whom we use the same distributed system. On the other hand, we also need to have some level of confidence in the system itself, and in that case we need to look at the institutional aspects of trust. Here, the main question is whether the technologies we rely on are trustworthy (Bodó, 2020). We can define technology in a narrow way, and thus the questions of trust in and trustworthiness of technical systems, and artefacts is simplified into the question of technical reliability: the security of computer systems, them being free of errors, and bugs, working as intended and advertised (Clarke, 2006). A broader definition would also consider the human and institutional elements which develop and operate those technical systems, and therefore give them agency. In such an approach, the question of trust becomes more akin to more traditional forms of institutional trust. The governance of technology covers these human and institutional elements, and the impact of the governance on the trustworthiness of technical systems turned this issue into a rapidly developing research field (Campbell-Verduyn, 2018; Elkin-Koren & Perel, 2019; Katzenbach & Ulbricht, 2019; Mattila & Seppälä, 2018). Finally, some technical systems mediate and produce trust relationships themselves (Bodó, 2020). For example, online reputation systems are designed to facilitate interactions that require trust. In these cases, the trustworthiness of these "trust producing systems" becomes an important issue in itself. The following remarks use blockchain as a case study to take a closer look at the controversies and questions associated with it from the perspective of trust.

The academic discussion on blockchain and trust

Blockchain technology—which was first introduced in 2008 in the context of the

digital currency Bitcoin—is often seen as a trust producing technology that might make trustworthy intermediaries such as banks obsolete. Instead, it is often said to replace human-based intermediaries by a "system based on cryptographic proof instead of trust" (Nakamoto, 2008, p. 1) i.e., a network in which all interactions between network participants are coordinated by mathematical and cryptographic code instead of human actors (Dodd, 2018, p. 37; Swartz, 2016). As a consequence, the technology takes a major role in the current public and academic discussion on trust and distributed technologies: some see it as a "machine for creating trust" (Berkeley, 2015), as reducing the cost of trust (Shahaab et al., 2020) or as an enabler of new technology-based modes of trust—"trustless trust" (e.g., Werbach, 2018a, 2018b; Hoffmann, 2015) or "distributed trust" (Botsman, 2017)—that might have a revolutionary impact on social coordination even outside the realm of distributed systems.

These academic discussions on blockchains and trust span across multiple disciplines such as computer science, economics, law and social sciences. Within these discussions, two key controversies can be identified: the first refers to the *conceptual* question of what is actually meant when referring to the term *trust*. The second controversy refers to the *substantive* question of how blockchain technology and trust are related: does blockchain increase trust, decrease trust, make trust obsolete, or represent a shift in the nature of trust?

Regarding the *conceptual* controversy, different understandings of trust can be identified. While some works understand trust as an attribute of the technological system itself (as e.g. suggested by 'trust models' rooted in computer sciences, see Harz & Boman, 2019), others rather understand trust as a system of intersubjective expectations between individuals that is not necessarily determined by technology (more often so in the social sciences, e.g. Vidan & Lehdonvirta, 2018). From the perspective of trust research, it is vital to recognise these conceptual differences, as these might have a significant impact on the substantive conclusions taken in respect to the nature of trust. Moreover, many academic works provide no precise and theoretically-informed definition of trust (e.g., Davidson et al., 2018; Flood & Robb, 2017; Beck et al., 2016), leaving its meaning vague and ambiguous.

In addition to these conceptual differences, academic works also exhibit *substantial* differences regarding how blockchain and trust are related. Two dominant views can be identified. Proponents of the first view stress the "trust-free" (Beck et al., 2016) or "trustless" (Harz & Boman, 2019; De Filippi & Hassan, 2016; Davidson et al., 2018) capabilities of blockchain technology, assuming it to enable coordination without requiring interpersonal trust between network participants (Maurer et

al., 2013, p. 261). In contrast to this view, the second line of academic works emphasises that blockchain networks are—in fact—not completely trustless and that trust enters the network at many levels and contexts (e.g. Corradi & Höfner, 2018, p. 203; Dodd, 2018; Vidan & Lehdonvirta, 2018). Rather than assuming it to abolish (interpersonal) trust, this line of studies rather argues for a *shift* of the nature of trust by blockchain, replacing interpersonal trust with trust (or: confidence, see De Filippi et al., 2020) in the distributed ledger itself (miners, consensus mechanisms, nodes), software developers (Walch, 2019) or new intermediaries (e.g. crypto-currency exchanges in Brekke, 2019, pp. 83-84). [1]

A similar conclusion of a shift in the nature of trust has been drawn in the academic discussion on "smart contracts" and their application in a legal context (Yeung, 2019; Finck, 2019; De Filippi & Wright, 2018). While, at first glance, smart contracts might offer new potentials of making trust obsolete due to the guaranteed execution of encoded legal obligations (Finck, 2019, pp. 72 ff), their real-life-application always requires trusted third parties (O' Hara 2017, p. 99), e.g. in the form of an "oracle" that supplies the smart contract with information from the outside world (De Filippi & Wright 2018, p. 75).

Takeaways for future research

Against the background of these controversies, two things can be learned for the study of trust in distributed systems: firstly, they corroborate the insight that finding a common theoretical language of the technological aspects of trust among multiple academic disciplines is of utmost importance. Secondly, the oft-quoted finding that blockchain resulting in a shift of trust rather than its abolishment leads to new empirical follow-up questions:

For instance, do network users put trust in the technology itself or in the humans behind it (Walch, 2019, p. 59)? [2] What are sources of trustworthiness of distributed (blockchain) systems, particularly in the case of legal (un-)certainty? How do users behave *vis-à-vis* a system which may or may not be trustworthy, e.g. in the case of the blockchain-based venture capital fund "The DAO" (DuPont, 2018)? Are the technical aspects of a blockchain system enough to establish their trustworthiness

1. Which components of a blockchain system require trust is largely dependent on its technological architecture. Major differences lie between public / permissionless and private / permissioned blockchain-systems, whereby the latter are usually not considered "trustless", as they afford one or more organisations in a maintaining role that need to be trusted (De Filippi et al., 2020, p. 2).
2. The importance of human actors for the perceived trustworthiness of a system has e.g. been recognised by academic works dealing with the interrelationship of trust and governance (e.g. De Filippi and Loveluck 2016).

(e.g. in the case of crypto-investors against questionable financial products)? How do past accounts of the trustworthiness of institutions (e.g. Sztompka, 1999) compare in relation to blockchain technology?

Addressing these questions should be an important objective for future academic research which might foster our understanding of blockchain technology and trust as well as the role of trust in distributed systems more generally. Important steps into this direction are for instance empirical studies on specific networks using blockchain technology (e.g., Woodall & Ringel, 2019; Meijer & Ubacht, 2018; Vidan & Lehdonvirta, 2018; Lustig & Nardi, 2015) as well as theoretical works that situate the case of blockchain within the broader discourse on trust and technology (e.g., Bodó, 2020; Jacobs, 2020). Moreover, as most empirical studies on trust and blockchain technology concentrate on the Bitcoin blockchain (e.g., Vidan & Lehdonvirta, 2018; Lustig & Nardi, 2015), it would be particularly interesting to see how this case compares to other blockchain applications.

Conclusion and working definition

In conclusion, we face the following fundamental question: How can we (or: do we need to) trust the (often anonymous) stranger on the other side of a screen? The case of blockchain illustrates that the answer to this question is subject to the changes in our techno-social environment. Blockchain technology can be viewed as exemplifying a change in mediation structures of trust from interpersonal trust mediated by human-based intermediaries to technological intermediaries. Developing new terms of trust that can account for this institutional change by blockchain technology and conducting empirical studies on this topic are therefore essential for further research on trust and distributed technologies. Based on our theoretical reflections above, we propose the following working definition of trust that might serve as a reference point for future studies on trust in the context of distributed technologies:

Trust is a complex social phenomenon with interrelated individual (psychological, attitudinal, informational), and systemic (economic, legal, technological, social) aspects. It is best understood as a relational attribute between (1) a social actor and other actor(s) (*interpersonal trust*) and / or (2) actors and institutions (*institutional* or *systemic trust*) and (3) institutions and (trusting) actors (*trust as shared expectations*), where institutional frameworks define the nature and strength of trust relationships between different actors. In essence, trust refers to expectations of the trustor made towards the trustee about the occurrence of future actions and / or events (under specific external / environmental conditions) which are often con-

nected to a risk for the trustor. *Trust* denotes the reliance on the trustee despite this risk and can thus be understood as a way of managing contingencies of modern life. It involves both emotional and cognitive elements and is thus to be distinguished from (blind) faith and confidence (Lewis & Weigert, 1985). In the face of recent technological change, we claim that the technological environment has played an increasingly important role in setting the conditions of trust relationships, as evident in the case of blockchain. Future research is needed to not only address the technical aspects of these technologies, but also study their broader social and cultural contexts shaping their emergence and production.

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