BLOCKCHAIN TECHNOLOGY IMPACTING THE ROLE OF TRUST IN TRANSACTIONS: REFLECTIONS IN THE CASE OF TRADING DIAMONDS

Research in Progress

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Abstract

Trust and trust theories have been studied across several academic disciplines for decades. Along with the growing prominence of blockchains, trust seems to be a key aspect of all blockchain applications. We hear the claim that blockchain technology could substitute for trust and wonder if any new technology could really make parts of well-established theories obsolete. We explore how blockchain technology changes the need for and the role of trust when trading high value physical goods. We outline the terms and theoretical concepts and analyze the role of trust when trading diamonds with or without blockchain technology along four characteristics of trust – the action, the trustor and trustee relationship, vulnerability, and the subjectivity. We find that blockchain technology simultaneously substitutes and complements for trust when trading diamonds. We discuss our findings and open a debate whether the impact of blockchain technology on granting trust is truly affects the role of intermediaries in the ecosystem. Finally, we conclude by promoting larger interdisciplinary IS-led work programs investigating how blockchains affect transactions, the role of trust, and the functions of intermediaries.

Keywords: Trust, Blockchain Technology, Diamonds

1 Introduction

Every day we hear and read news about blockchain applications like Bitcoin or Everledger. Tapscott and Tapscott (2016) compare the blockchain technology in its importance to the development of the internet. The strong public interest arises from the unique characteristics of blockchains. As an open and distributed ledger that can record transactions efficiently, permanently and verifiably, blockchain technology has the potential to open up new business models and make traditional ones obsolete. Intermediaries like notaries, banks, or lawyers might not be necessary in the future any more.

The blockchain was first described as a part of the Bitcoin protocol by 'Satoshi Nakamoto' in 2008. Bitcoin needed a way to record and validate transactions and the blockchain was the answer (Fanning and Centers, 2016). In the following years, research on blockchain applications mainly focused on Bitcoin (Yli-Huumo et al., 2016). It has investigated technological aspects, such as different blockchain types, consensus mechanisms, crypto-currencies, and governance mechanisms (De Kruijff and Weigand, 2017), has barely digged into trust related issues. Nevertheless, trust seems to be a key aspect in the context of potential blockchain-driven transformations. This suggests further exploring the impact that blockchain technology can have on the role of trust in transactions.[1]

Here, in this qualitative paper we aim to make a contribution. We outline the terms and theoretical trust-related concepts for investigating how the blockchain impacts the role of trust in transactions along four characteristics of trust – action, trustor and trustee relationship, vulnerability, and the subjective matter (Wang and Emurian, 2005). Taking diamonds as an example of high-value goods, we analyze how trading diamond without and with blockchain technology impacts the role of trust in the respective transactions. We discuss our findings that blockchains complement and substitute trust setting mechanisms before we conclude with promoting larger interdisciplinary IS-led work programs investigating how blockchains affect transactions, the role of trust, and the functions of intermediaries.

2 Blockchain Basics

The blockchain is a verifiable, immutable and distributed database or ledger for transactions of any kind based on a consensus mechanism (Beck et al., 2016; Crosby et al., 2016). It records and verifies all transactions and digital events that occur between participating parties by consensus of the majority of clients in the blockchain network. Further, it makes all transactions transparent and accessible; they cannot be erased or altered. Transparency and consensus mechanism ensure that only valid transactions are executed.[2]

The most widely known *blockchain applications* are in the FinTech sector. *Bitcoin* is a crypto-currency as well as a system to make digital payments (Brito and Castillo, 2013; Nakamoto, 2008). Different from current payment systems via banks, it offers the users anonymity (Ludwin, 2015). InsureTech companies register property with the help of the registry *Everledger*; companies going public take advantage of blockchain providers like *Medici* or *Blockstream* (Nofer et al., 2017). Prominent non-financial applications are anti-counterfeit solutions which ensure authenticity of products (e.g., *Blockverify*) or replace a notary's validation of interactions (e.g., *Stampery*). The blockchain is also used in IoT applications (e.g., *Filament Adept*) and in so-called 'smart contracts' where the rules of the contract are encoded in a computer code on the blockchain (Peters and Panayi, 2016).

[1] Due to given space limitations, we take the liberty to focus on the trust related issues.

[2] For further technical – and perhaps more IS specific – aspects of the blockchain technology, we refer to the fast growing IS literature (e.g., Beck et al., 2016; Beck et al., 2017; Beck and Mueller-Bloch, 2017; Hari and Lakshman, 2016; Iansiti and Lakhani, 2017; Naerland et al., 2017; Wattenhofer, 2016; Woerner et al., 2016; Zyskind et al., 2015).

3 Trust

3.1 Definitions, Characteristics, and Architectures

Trust is a basic factor in any interaction that occurs between humans (Gambetta, 1988) and widely understood as a multi-faceted concept with cognitive, emotional, and behavioral dimensions (Lewis and Weigert, 1985). The concept of trust is firmly anchored in many academic disciplines psychology, philosophy, and economics (Baier, 1986; Good, 1988; Sako, 1992) leading to a variety of *definitions.*

Sabel (1990) defines trust rather generally as "(t)he mutual confidence that no party to an exchange will exploit the other's vulnerability". According to Good (1988: 33) "trust is based on an individual's theory as to how another person will perform on some future occasion, as a function of that target person's current and previous claims, either implicit or explicit, as to how they will behave". This sociologically based definition emphasizes the subjectivity of the trust experience in a psychological context and the interpersonal aspect. Baier (1986: 235) defines trust from a philosophical perspective as "accepted vulnerability to another's possible but not expected ill will (or lack of good will) toward one" and thereby stresses the vulnerability and the dependency that come along with trust. In economics and in organizational / management studies, the concept of trust always includes an interaction of a trustor and a trusted person. Sako (1992: 37) defines "trust as a state of mind, an expectation held by one trading partner about another, that the other behaves or responds in a predictable and mutually acceptable manner". Similarly, Gambetta (1988) and later Mayer et al (1995: 712) define trust as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party". In Information Systems (IS) and especially in the context of online environments, Gefen et al. (2008) focus on trust resulting from beliefs in the trustworthiness of a trustee, which is composed of integrity, ability, and benevolence (see also Gefen, 2002; McKnight et al., 2002).[3] Soellner (2015) points to a number of complementing definitions of trust in mainly empirical works in the fields of management and IS.

In spite of different definitions and understandings, *four characteristics* are commonly accepted to be part of any interaction depending on trust (Wang and Emurian, 2005). These are (1) the *action*, (2) the existence of a *trustor-trustee relationship*, (3) the *vulnerability*, and (4) the *subjectivity* of trusting and trust.

- Trust leads to an *action* by a partner within a trustor-trustee relationship. Such action is risk-taking behavior, where the trusting party takes the risk to lose something. The "willingness to take risks may be one of the few characteristics common to all trust situations" (Johnson-George and Swap, 1982: 1306).
- In any *trustor-trustee relationship* there must be one party who trusts (trustor) and one party who is trusted (trustee) in any trust relationship. The involved parties can be people, devices, technologies, or organizations.
- Trust comes along with a *vulnerability* of one person's or organization's regarding the outcome from the other's action. I.e., trust is only necessary in risky and unpredictable environments where trustors accept to be vulnerable to a potential negative outcome resulting from an exploitation of the trust by the trustee.
- The *subjectivity* of trusting and trust perception is embedded in trust being experienced differently depending on the trustor's characteristics and situation. Blomqvist (1997) distinguishes the competence dimension and the goodwill dimension of trust. Trust in competence means that the trustor believes in the trustee's technical and managerial skills and know-how to fulfill the agreed

[3] For coverage of the concept of trust in the e-commerce and the e-business literature, see for instance Ba and Pavlou, 2002; Gefen et al., 2003; Gefen and Pavlou, 2012; Jarvenpaa et al., 2000; Kim et al., 2009; Moody et al., 2017; Vance et al., 2008; Wang and Benbasat, 2008.

deal. In contrast, trust in goodwill describes the trustor's expectation that the trustee does not have any negative intentions and acts in accordance with morality.

Two major *trust architectures* enable trusting behavior; they form the basis for most trust relations: (1) the delegation of the power and (2) the interpersonal trust relation.

- Trust is reached through the *delegation of power* to a third party or an intermediary that enforces parties to perform in the expected and agreed way (Luhmann, 1979). Such powerful third parties can be governments, organizations, or companies (Ellickson, 1994). The confidence in the other party's action is the result of the third party's power to enforce the agreed conditions of the transaction and her ability to control the other player's behavior (Blomqvist, 1997). Delegation to a third party is often combined with higher cost and not always practical (Shell, 1991). However, it is a good choice if one can engage a third party capable of ensuring validity of transactions at reasonable costs.
- The *interpersonal trust relation* builds on direct trust between involved parties. This can arise when the trusting player knows the other players personally and believes in their goodwill and competence. It can also arise when players in a transaction share common norms and believe leading to all of them behaving acceptably within the framework of the shared norms (Ostrom, 1990). Interpersonal trust on a peer-to-peer basis is limited to small scale applications where players have personal connections. In online transactions without any interpersonal contact, it is difficult to reach (Christopher, 2016).

Both trust architectures have their shortfalls, such as the need to engage a third party and the limitation to small scale applications. This raises the question whether there are other ways to ensure trust, or whether there are ways to substitute trust through other mechanisms.

3.2 The Role of Trust in Transactions

Trust has a positive impact on economic activities, as it enhances transactional outcomes (Arrow, 1974). It simplifies transactions, makes extensive contracting unnecessary, and thus leads to substantial cost savings and closer cooperation (Shell, 1991). This positive effect is reinforced through feedback mechanisms making it stronger the more the partners cooperate (Bachmann and Zaheer, 2006; Ostrom, 2010).

According to the New Institutional Economics (NIE), which deal with "transactions cost analysis of property rights, contracts and organization" (Rutherford, 2001: 187), the economic importance of trust is embedded in any market transaction. Bounded rationality in economic transactions is at its core; perfect forecasting and complete contracts are not possible. Asset specificity implies that certain investments create a more positive outcome in that specific transaction than in another one (Bachmann and Zaheer, 2006). Opportunism leads to individuals behaving in their own favor.

Opportunism and how to safeguard against opportunistic behavior are at the core of transaction cost economics (Williamson, 1979). Contracts are a way to prevent opportunistic behavior and thereby limit the incentives to behave opportunistically. However complete contracts are rare and a contract is only valuable if one believes in or trusts the other party's willingness to stick to the terms of the contract (Woolthuis et al., 2005).

The relationship between trust and contracts is ambidextrous. Trust is necessary in any form of economic activity (Rothstein, 2005) except for the theoretical case of 'complete information, no transaction costs, and rational behavior of the involved agents' (Davidson et al., 2016). Trust is required in transactions with incomplete contracts. The need for trust results from the necessity to control the other party's opportunistic behavior (Williamson, 1985). Contracts help to ensure that partners are acting according to the agreed conditions. "Complete, that is, unconditional or blind trust, is ill advised, and where trust ends, one needs control. Vice versa, complete control is impossible, and trust is needed where control ends", states Nooteboom (2013: 107). However, judging the other party's trustworthiness is impossible or comes at a high cost (Williamson, 1981).

In the context of blockchain applications, the claim for fame has been that it supposedly enables trust-free transactions making direct trust in the other party's action unnecessary (Beck et al., 2016) and thereby eliminating opportunism (Davidson et al., 2016). Hence, deploying blockchain technology potentially impacts those applications that traditionally relied on third parties to establish trust to make transactions happen (Beck et al., 2016; Hayes, 2015; Nofer et al., 2017; Reijers et al., 2016).

4 Blockchain Technology Impacting the Role of Trust in Trading Diamonds

Since prices for high value goods are high, consumers want to ensure that the goods are of the expected quality and originate from a reliable source (Abeyratne and Monfared, 2016). Prices that buyers pay positively correlate with the seller's reputation (Kollock, 1999). In trading goods that have a high value trust plays a crucial role

High-value goods are always prone to forgery and trading high-value goods needs mechanisms to ensure that the sold items are original. The difficulty to detect stolen products affects insurance companies. People claim their goods are stolen and demand money from the insurance even though they might have sold them themselves. This problem is especially critical for products like diamonds that do not depreciate in value over time (Lomas, 2015). In the trade of diamonds, implementing a serial number has become common; however, it has not been sufficient to prevent fraud entirely (Hackius and Petersen, 2017).

As it is hardly possible to create transparency regarding the trading process, trading high-value goods such as diamonds heavily depends on trust. Trusting in the validity and legitimacy of the offered goods is dependent on correct and complete information about the goods and their prior owners (Yeoh and Yeoh, 2017). However, the traditional documentation to ensure the originality of the goods is on paper and it can easily be altered.

Below, we analyze two settings of trading diamonds – without and with blockchain technology – in order to delve into the potential of blockchain technology to enable trust-free transactions or to make trust in the other party's action unnecessary (Beck et al., 2016): We do so along the four trust characteristics introduced above.

4.1 The Role of Trust in Trading Diamonds *without* Blockchain Technology

As explained above, diamonds could not be traded without trust in the other players' benevolent actions, the reliance on the involved parties' reputation, and the validity of the certificates. This is shown along the four characteristics of trust:

- *Action*: Ultimately, trading diamonds in the store includes mining the stones, valuing the diamonds, shipping the diamonds, polishing and cutting the diamonds, and finally selling them (Cross, 2011). Trust is required in each step to ensure the legitimacy of the diamonds. Adequate and sufficient information about each diamond has to include its characteristics, its origin, the involved parties in bringing it from the mines to the counter, taxes paid, and a proof of ownership. Traditionally, one can only trust paper certificates or receipts that are used to document the history of a diamond (Bandelj et al., 2017), even if there is no way to get and forward all these information to the end-consumer in order to check the legitimacy of the process (Passas and Jones, 2006).
- *Trustor/Trustee Relationship*: In a diamond sale, the trustor is the end-consumer who must trust that the diamonds are mined, distributed, and sold legally and that they have the promised quality. A trustee is each player, who is – at some point in time – in possession of the diamond or who is involved in mining or transporting it. Traditionally, one has had to trust the pieces of documentation provided along the trading process (Bandelj et al., 2017). Furthermore, some companies require their suppliers and business partners to follow certain business practices attempting to suppress illegitimate transactions (Cross, 2011).

- *Vulnerability*: The main problems in the diamond industry causing vulnerability are fraud and theft. Fraud relates to the quality of the diamond or to illegal mining. Theft concerns cases where stolen diamonds are traded without being able to trace back the origin of the diamond (McLean and Deane-Johns, 2016). A specific issue arises from so called 'blood diamonds'; they stem from war zones and are typically used to finance wars. Naturally, they are difficult to detect due to their non-transparent origin, which is wanted by the seller (Smillie, 2010). The traditional system of trading diamonds lacks a universal mechanism that ensures diamond legitimacy. There is no monitoring and enforcing entity – even less so in countries missing proper government surveillance or even facing war situations (Kaplan, 2002; Passas and Jones, 2006). The overall documentation system is prone to manipulation. The paper-based documents easily get lost or illegally changed in favor of one party, This makes the trade of fraud diamonds possible (Bandelj et al., 2017) and leads to inefficiencies due to the amount of work required to produce and circulate the documents (Cross, 2011).
- *Subjectivity*: A certain amount of trust in the other parties involved is inevitable. Traditionally, it is based on prior experiences and the trading partners' reputations (Passas and Jones, 2006).

4.2 The Role of Trust in Trading Diamonds *with* Blockchain Technology

If diamond data is inserted correctly in the blockchain, trust throughout the process of trading diamonds is ensured through the transparent record of all actions, which are – at least theoretically – accessible by all parties involved when deploying blockchain technology.

- *Action*: The blockchain can be used to build a ledger that shows all certifications that a diamond has received and its complete owner and shipment history. Each diamond gets a unique electronic identity that includes all its attributes such as weight, height, and color (Walport, 2016), which allows for precisely identifying the diamond (Crosby et al., 2016). A digital passport with all its past and future actions is assigned to each diamond and saved in the blockchain (Volpicelli, 2016). It is possible to track the ownership as well as to authenticate each transaction and characteristic of the diamond throughout the trading process. This allows for detecting illegal activities in the trade process. Fraud diamonds lose value; deception becomes less attractive (Walport, 2016). Consumers are prevented from buying 'blood diamonds' and insurances from being a victim to insurance fraud (Abeyratne and Monfared, 2016).
- *Trustor/Trustee Relationship:* Trustors in trading diamonds are end-consumers and insurances. End-consumers have to trust that they buy diamonds which have been legitimately traded and do not stem from war zones. Insurance companies have to trust that fraud is detected (Nicoletti, 2017).

  The main trustee in trading diamonds with blockchain technology is the blockchain itself when it replaces paper certificates (Abeyratne and Monfared, 2016). It 'contains' records of ownership and transactions, which are stored in a ledger accessible to all participants. Cryptographic validation and the blockchain consensus mechanism ensure validity. Further, trustees are the parties who verify the process of digitizing the diamond attributes and register them in the ledger (data preparation and input). Those parties are typically insurance companies, law enforcement agencies, diamond owners, and mining companies (Nicoletti, 2017).
- *Vulnerability*: As any technology, the blockchain technology itself could show technological problems in the hardware, software, or data transfer components. Or, the blockchain system as a whole could be attacked and transactions could be tampered. Furthermore, the process of entering data (e.g. registering diamonds) into the blockchain may suffer – may it be by mistake or may it be due to entities with malicious incentives, who work in their own favor and, for example, register fraudulent diamonds in the blockchain. If the registering is not done correctly, the blockchain cannot detect the fraud (Crosby et al., 2016).
- *Subjectivity*: The use of a blockchain makes the trade of diamonds more formal. It requires less trust in documents or other players, hence reduces the role of trust (Walport, 2016). The proof of ownership and the validity of transactions are clearly stated and not any longer a matter of disputes

(McLean and Deane-Johns, 2016). However, subjectivity still plays a role in that people must trust the blockchain itself – and the people who enter the data at the beginning of the process (e.g., in case of 'blood diamonds').

5 Discussion and Conclusion

One of the main claims for the economic success of blockchains is that they allow for substituting trust in people through trust in a system and thereby significantly reduce transaction costs (including the costs of maintaining trust providing institutions along the value chain or in the ecosystem). Buyers do not need any longer to directly trust sellers and other parties involved; they can rely on the blockchain system. Transactions that were previously based on informal relations between different players involved and counted on a complicated and easily tampered documentation could be substituted through transparent and secure transactions executed on the blockchain.

As a consequence, consumers could be incentivized to pay 'higher' prices if they 'trust' the originality and quality of the diamonds. A transparent proof of ownership based on a digital diamond identity and the traceability of all related actions in the blockchain help avoiding fraud and illegal measures.

Ideally, the blockchain solves the problem that it is almost impossible to judge the other party's trustworthiness in advance (similar to the well know issue of experience goods) and can serve as an alternative to the former trust architectures. It enables transactions even when there is no direct trust relation between the parties. Further, it replaces a third party along a trading or value creation process, which used to have the power to enforce agreed terms. As all actions in the blockchain are visible on the ledger, the technology prevents players' hidden intentions and malicious actions. Finally, the consensus mechanism avoids recording fraudulent transactions in the ledger.

However, some trust is still required – at the interface between the physical item traded and the protocol in the blockchain, and in the parties verifying the quality of the good, in our example – the diamond.

Trust and blockchain technology are simultaneously substitutes and complements. On the one hand, the blockchain offers control since transactions are validated and can be checked; thereby it substitutes trust to a certain extent. On the other hand, the blockchain technology would not work if users did not trust in the system. As complete contracting is barely possible, some trust is necessary in almost all business transactions. In the case of trading physical goods, for instance the interface between the digital and physical world requires trust.

Finally, we would like to raise a more fundamental concern: We think that the potential benefits of blockchain technology as outlined above for trading diamonds are clear and generally agreed upon. However, we are still unsure whether such logic would lead to substituting intermediaries – the main impact, concern or 'claim to fame', in the press and broader public.

Please note how we use the word 'to trust'. Earlier in this text, we used it in the context of trustees, i.e. institutions, players, or (blockchain) technology. But, almost in contrast, when summarizing and discussing about the potential benefits of the blockchain in trading diamonds, we point, for example, to end-consumers trusting the originality of a diamond, i.e., to trusting the result or the output of trustees' actions. While our language and wording may not be good enough, we would like to further discuss whether one trusts institutions, persons, technology or the output / result of their actions.

Further, we are unsure that providing trust is the main function of intermediaries in a value chain or an ecosystem. If so, deploying blockchain technology could probably lead to eliminating them. If not, however, one should not only analyze if and how blockchain technology affects intermediaries also with regard to other functions. In that case, one would also have to conduct a rather different cost-benefit analysis – considering blockchain technology a certainly valuable add-on improving the value and increasing the costs of transactions.

To us, this debate – with whatever words – is crucial for further conceptualizing the impact of blockchains on the role of trust, transactions, and market constellations.

6 Limitations and Future Research

This early explorative research has several limitations. First and foremost, the qualitative analysis would benefit from detailed quantitative research to support the claims with concrete empirical data. Secondly, we have investigated only one, rather special sector of trading physical goods. Investigating other physical goods sectors would shed more lights on our claims regarding the almost omnipresent concern of trust. Lastly, we took most of the blockchain 'facts and insights' for granted and purposefully focus on the more general and long lasting trust issues in the context of a new technology. Some readers (and reviewers) may expect a stronger technology focus in the context of an IS conference.

Future research opportunities are enormous. One may want to conduct quantitative research to support the derived claims. For instance, diamond trade could be presented as a series of information or knowledge-based transactions with an explanation of how these could be influenced by blockchain technology. Or researchers may want to extend the analysis to other industry sectors outside the FinTech sector (by far the best researched in the context of the blockchain). Along another line of thought, one could dig into the impact of energy requirements in the context of blockchain technology. The blockchain 'proof of work' mechanism needs a lot of energy. It would be helpful to gain a better understanding of the transactional (and economics) efficiency of the blockchain system compared to centralized systems. Finally, we only scratched the surface of how trust theories and concepts will be impacted by blockchain technology. To us any related conceptualizations will be at the core of future interdisciplinary work at least as soon as the technical development of blockchain technology will have reached maturity. Assuming that blockchain technology will soon become prominent in many practical fields and academic disciplines, it would be worthwhile to further study its impact on trust and the need for trust through various scientific lenses. Here, it would be very good if the IS discipline could lead such initiatives and encourage interdisciplinary work programs.

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