Blockchain Ethics Research: A Conceptual Model

Yong Tang
Center of Cyberspace & Security
School of Computer Science and Engineering
University of Electronic Science & Technology of China
Chengdu, Sichuan, China
tangyong@uestc.edu.cn

Jason Xiong
Computer Information Systems & Supply Chain Management
Walker College of Business
Appalachian State University
Boone NC, USA
xiongjj@appstate.edu

Rafael Becerril-Arreola
Department of Marketing
Darla Moore School of Business
University of South Carolina
Columbia SC, USA
rafael.becerril@moore.sc.edu

Lakshmi Iyer
Computer Information Systems & Supply Chain Management
Walker College of Business
Appalachian State University
Boone NC, USA
iyerls@appstate.edu

ABSTRACT

Blockchain is being widely adopted far beyond finance into numerous domains of society and promises unprecedented potential to disrupt organizations, businesses, industries, and economies. However, blockchain is still in its infancy and its future is highly controversial, arousing phenomenal enthusiasm, high expectations, and even intense criticism. The possible impacts of blockchain and its applications on the society could be fundamental and revolutionary, inevitably bringing unpredicted ethical challenges in the foreseeable future. Identifying the ethical challenges of blockchain is urgent and critically needed to ensure that blockchain is adopted ethically. However, discussions on the ethics of blockchain are largely insufficient, which leaves a void of theoretical understanding so far. In this paper, we provide a systematic discussion on the ethics of blockchain applications and map the main social challenges raised by its technology and applications. The paper starts with a review of the technological concepts and applications of blockchain. Then, it overviews the current research on the ethics of technologies and general research on blockchain to briefly introduce the authors' approach. Afterwards, a conceptual model of blockchain ethics research is developed. This research hopes to serve as an initial roadmap for the study of blockchain ethics, and to raise timely awareness and stimulate further debate on the ethics of blockchain in the IS community.

SIGMIS-CPR '19, June 20–22, 2019, Nashville, TN, USA

ACM 978-1-4503-6088-3/19/06…$15.00
https://doi.org/10.1145/3322385.3322397

CCS CONCEPTS

• Social and professional topics • Professional topics • Computing profession • Codes of ethics

KEYWORDS

Blockchain, Cryptocurrency, Decentralization, Society & Ethics, Emerging Technology.

ACM Reference format:

Yong Tang, Jason Xiong, Rafael Becerril-Arreola, and Lakshmi Iyer, 2019. Blockchain Ethics Research: A Conceptual Model. In *Proceedings of ACM SIGMIS-CPR'19, ACM, Nashville, TN, USA. ACM, New York, NY, USA.* 7 pages. https://doi.org/10.1145/3322385.3322397

1. INTRODUCTION

Blockchain is the distributed ledger technology underlying bitcoin and other cryptocurrencies [1]. Nonetheless, its usage is dramatically expanding beyond the financial industry into other domains of society [2, 3]. Potentially as revolutionary as the Internet and artificial intelligence, blockchain promises disruptive innovations in technology, business models, and social governance. Blockchain provides a trustless computing infrastructure for large-scale applications that has potential to solve fundamental trust issues and allow economic transactions to take place without intermediaries.

Recent years have witnessed an emergence of game-changing applications based on blockchain in a variety of fields such as FinTech (Financial Technologies), sharing economies, healthcare, science, and government and law [4-6]. Blockchain promises to significantly extend the horizons of the digital economy and society by bringing openness, sharing, and security to a whole new level. Blockchain-related entrepreneurial involvement is flourishing globally, generating sophisticated applications and solutions. While the recent boom of blockchain startups is phenomenal, real-world adoption is still limited. Governments and other organizations are thus actively and carefully watching the development of blockchain. There are still concerns regarding blockchain and its applications partly because, inevitably, the adoption of blockchain poses ethical and moral challenges due to limited understanding of its potential consequences. Optimism about the development of ethical machines, in general, is not yet warranted because of their rapid technological progress on face of limited understanding of their consequences [7]. Unforeseen negative impacts might lead to a grim aftermath and thus the ethics of blockchain should be studied to identify its potential consequences and help decision makers.

Overall, the research question is: ***How can the study of blockchain ethics be structured?*** This paper attempts to offer an initial answer by proposing a conceptual model of blockchain ethics from an information systems perspective. First, the paper lays the foundation for the conceptual model by reviewing the concepts behind blockchain and identifying the major and best-known applications of blockchain. Second, the paper reviews the current research landscape and discusses how it is used to derive the proposed conceptual model. Third, the paper presents the proposed conceptual model of blockchain ethics that systematically covers the major ethical issues of cryptocurrencies and other blockchain applications and that is intended to serve as a roadmap for future studies. Fourth, the paper suggests future research directions.

2. BACKGROUND

Blockchain originated less than a decade ago as the distributed ledger technology (DLT) that supports bitcoin [1]. By creating a trustless environment, blockchain allows stable, robust, algorithm-ensured data storage and transaction authorization, as well as autonomous processing. As understanding of the critical technical concepts is necessary for a clear understanding of the ethics of blockchain, just like a basic understanding of computers is required to understand the ethics of computers [8], the following section presents the central concepts underlying the blockchain technology.

2.1 Main Concepts

In traditional information systems, from small-scale enterprise systems to cloud-based Internet services, all data are stored in centralized databases. Though such databases can be deployed in distributed computing environments, their control and ownership remain centralized. The data are owned and maintained by a central party who has absolute authority over them as a result of management rules, business model arrangements, organization authority, or law enforcement. Other users have no choice but to trust the central party by default. In blockchain, in contrast, all transaction information is stored across peer nodes that form a distributed computing environment. New transactions are verified by peers running consensus algorithms. Once confirmed, transaction information is stored in blocks in chronological order and chained together to form a blockchain. Copies of the blockchain are collectively maintained by all computing peers without relying on specific central servers. Technically, a blockchain is a distributed ledger kept by all peer parties with all transactions embedded into immutably growing record blocks that are protected by cryptography and distributed consensus mechanisms [1]. Openness, decentralization, transparency, pseudonymity, and immutability are the fundamental merits that distinguish blockchain from other traditional computing solutions. Thanks to the ongoing advances in information security, cryptography, algorithms, and networking, blockchain technology is improving dramatically to meet industrial needs for low latency, high throughput, and good scalability [9].

There are different implementations and services at different levels of blockchain. In the first level, transactions are assembled into blocks using consensus algorithms. A unique *nonce* value (i.e., a random or pseudo-random number issued to ensure that existing blocks cannot be reused) is mined and a timestamp is assigned to each block. *Hash* values (i.e., fixed-length data summaries that prevent data tampering) of transactions are calculated and combined into tree data structures, whose roots are also stored in blocks [1]. Because each hash value is computed using the hash value of the last block in the chain, blocks are linked in linear, chronological growing order to form the immutable data container that constitutes a blockchain. Various types of blockchains provide implementations of distributed open ledgers for different situations with different controls on permissions and accessibility. At the highest level, executable smart contracts are offered to empower autonomous applications in areas like Fintech, digital property, cybersecurity, and autonomous contracts. Through this structure, blockchain's trustless computing environment transforms the network of information into the network of value. This may open up unlimited opportunities for decentralized autonomous organizations (DAO), decentralized business ecosystems, and possibly decentralized societies.

2.2 Blockchain based Applications

To understand blockchain ethics, it is essential to illustrate the application possibilities of blockchain. As shown in Table 1, the potential applications of blockchain are numerous and diverse. The secure nature of blockchain can open plenty of opportunities in real estate registry, data protection, luxury goods registry, document tracking, ownership authentication, healthcare records sharing, copyright management, and supply chain management. Cryptocurrencies and other blockchain-based innovations, together with artificial intelligence and big data, are shaping the future of the financial industry [10]. For data assets, blockchain ensures data authentication, transparency, and efficient sharing. Such transparency is essential for algorithms and artificial intelligence to be ethical [11]. Blockchain-ensured transparency may then enhance the quality of and the confidence in the data that is fed into those algorithms and artificial intelligence, thus addressing *garbage in garbage out* issues. In the scope of cybersecurity, blockchain can enhance the security of data and systems, providing robust solutions when threats are constant, environments are complicated, and traditional measurements are expensive. Moreover, applications of smart contracts are promising in many domains like finance, trading, supply chain, insurance, and governance. These applications have rich implications for society at different levels.

Table 1: Some Major Applications of Blockchain

Domains	Potential Applications
Finance	Cryptocurrencies; Exchanges; Financial services; Banking; Insurance; Cross border payments; E-commerce; Micro-payments; P2P lending; Crowdfunding
Digital Property	Intellectual property; Artwork registry; Identity management; Copyright management; Healthcare records Sharing; Supply chain tracking; Real estate registry;
Cybersecurity	Identity protection; Privacy protection; Critical infrastructure protection; IoT security and control
Smart Contracts	Autonomous transactions; Autonomous organizations; Autonomous markets; Autonomous societies; Algorithm-based legal systems

3. RELATED STUDIES

Traditional ethical theories provide a root for discussions on the ethics in information systems. Consequentialism or teleology focuses on the morality of consequences rather than the actions, in this approach, utilitarianism emphasizes the maximization of the output utility [12, 13]. On the contrary, Kantian deontology looks into the means, duties, and intentions with little concerns to the results [12, 14]. Different from teleology and deontology, virtue ethics concentrates on the characters of individuals [12]. In this line of ethics theories, technological revolutions during the past half century have stimulated a thread of ethics studies on emerging technologies [7, 8]. There is copious research on the ethics of information technology [15, 16], computers [15], machines and robots [7], the Internet [17], cloud computing [18], big data [19], algorithms [20], and more recently artificial intelligence [11].

Ethics studies in information systems also contribute to the understandings of ethical challenges in the intersections of technology, human being, business, and society [21], such as the ethics of information technology [22-25], computer ethics [26], professional ethics [28, 29], piracy and file sharing [30-32], corporate domain ethics [28], Social network and Internet marketing [33-35], knowledge management [36], and ethical behaviors [37]. More recently, in the IS community, research on blockchain [38-40], the economics of cryptocurrencies [41-44], domain applications [45-49], case studies [50, 51], etc. are emerging. However, the ethical aspects of blockchain technology and applications have been barely studied and room exists for a conceptual model to be developed. Beyond ethics, the applied research propelling blockchain is interdisciplinary and involves computer science, economics, management, business, policy, law, and philosophy. Despite the wide interest from industry, academic research on blockchain is still in its infancy [52]. Furthermore, most existing studies focus on the technological aspects with only a handful of works discussing perspectives from the social sciences, business management, law, and, in particular, philosophy. The disruptive and transforming potential of blockchain requires further study of aspects beyond the technology itself.

Given its focus on the ethics of blockchain applications and their consequences, this study pursues an approach closer to that of teleology. To derive the conceptual model, we survey the literature to identify four major realms of blockchain that define four groups of blockchain applications: blockchain's technology stack, cryptocurrencies, smart contracts, and system decentralization. For these groups, ethical concerns already raised in the literature are collected and organized. Concerns that have not been raised or that have not received sufficient attention are likewise identified.

4. CONCEPTUAL MODEL

Since blockchain is developing dramatically, it is impractical to cover all of its ethical issues. We develop a conceptual model by investigating the following four realms of blockchain, their corresponding applications, and their ethical issues, as shown in Figure 1. (1) *Technology stack*. The underlying distributed ledger technology stack is the foundation of any blockchain implementation and application. The technology stack presents ethical issues in the technological domain. (2) *Cryptocurrencies*. Blockchain-based cryptocurrencies exhibit unique features as a globally-accepted payment method. The ethical issues in this realm stem from the use of cryptocurrencies as alternatives to fiat money. (3) *Smart contracts*. Autonomously executable programs running on the blockchain environment enable automatic transaction and information processing. The digitalization and exchange of financial assets bring new ethical challenges in a blockchain-enabled environment. (4) *Decentralization*. The concept of decentralization is more general than blockchain, which is only a specific implementation of distributed ledger technology. Broader and deeper ethical issues arise from the potential impact in the transformation of systems from centralized to decentralized. The ethical issues of these four realms of blockchain are discussed below.

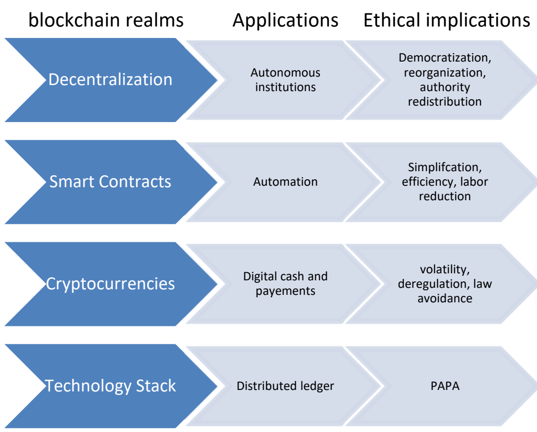

Figure 1: Conceptual Model of Blockchain Ethics

4.1 Ethics of Blockchain's Technology Stack

The blockchain stack is designed as a peer-to-peer-computing, shared ledger. The peer-to-peer structure minimizes centralized computation and authority [53]. Features of the blockchain technology stack are peer-to-peer computing, various kinds of consensus algorithms, immutability of historical data records, and collective authentication. This unique combination makes blockchain stand out as an innovative distributed shared ledger.

Data ethics include privacy, security, and digital rights [54]. To study blockchain ethics at the technology stack level, the PAPA framework proposed by [15] for information ethics provides a theoretical lens. The four elements of PAPA, including privacy, accuracy, property, and accessibility, are also the core issues of blockchain ethics at the technology and data levels.

4.2 Ethics of Cryptocurrencies

The nature of money in a digital society has become a more important question than how money is transacted [8]. Blockchain's technology has raised new questions regarding the nature of money by giving birth to bitcoin and other cryptocurrencies. Nowadays, cryptocurrencies have in fact been used as a replacement of fiat money in many domains [5, 55], propelling blockchain beyond Fintech [6, 56]. Key applications include cashless payments, micropayments, cross-border money transfers, cryptocurrency-based e-commerce, and investment markets. Despite free competition among cryptocurrencies and its morally ambiguous role in denationalizing currencies [57], bitcoin still dominates cryptocurrency markets. In Table 2, key differences among gold, fiat money, and cryptocurrencies are identified before exploration of the ethical aspects of cryptocurrencies.

Table 2: Key Differences among Gold, Fiat Money, and Cryptocurrencies

Factors	Gold, silver	Fiat money	Cryptocurrencies
Existence	Physical	Paper	Digital data
Intrinsic value	Valuable precious medal	No	No
Medium	Ideal but inconvenient	Ideal and convenient	Very ideal and convenient
Value storage	Best	Median	Uncertain
Divisibility	Good	Median	Best divisibility
Scarcity	High scarcity	Scarcity	High scarcity
Supply limits	Natural	Policy-driven	Mathematical
Origin	Mining labor	Issued by government	Algorithm
Authentication	Scientific assay testing	Central banks	Blockchain technology
Regulation	Strictly regulated	Strictly regulated	No regulation
Inflation	Anti-inflation	Highly possible	Anti-inflation
Anonymous	Perfect	Perfect	Pseudonymous
Falsifiability	Strong	Weak	Perfect
Circulation	Less efficient	Efficient	Highly efficient
Cost	High	Cheap	Cheap
Acceptance	Global	Global	Global
Market	Mature and stable	Mature and stable	Immature and volatile
History span	Thousands of years	Hundreds of years	Ten years

Despite massive enthusiasm in industry, cryptocurrencies remain surrounded by severe concerns. Aside from a series of recent scandals and adverse events, there are concerns about cryptocurrencies being a Ponzi scheme, questions about whether they qualify as acceptable currencies, and controversy on the fairness of their mechanisms. While cryptocurrencies are ethically neutral as payment tools [58], their effects on the economy and society extend far beyond their consequences to the payment processing industry. Considering the broad implications, both realized and expected, of cryptocurrencies, it is crucial to characterize their ethical nature systematically.

Compared to the abundant research on the technical aspects of cryptocurrencies, the study of cryptocurrencies ethics is so rare that only a handful of publications exist. Two studies are particularly relevant. In the first study, Dierksmeier and Seele [57] present a three-level assessment matrix to study the business ethics of cryptocurrencies. The matrix classifies ethical issues, according to the scope of their impact on society, into three different catalogs. *Micro* issues relate to individuals, *macro* issues relate to the aggregate system, and *meso* issues lie between the other two levels [57]. For each level, the ethical aspects are classified as *Good*, *Bad*, or *Ambivalent*. The benefits of cryptocurrencies in payments, business operations, and as a substitute to traditional money are qualified as *Good*. Meanwhile the drawbacks related to potential abuse, volatility, and tax evasion are qualified as *bad*. Privacy issues, the competition among cryptocurrencies, and the reduction of administrative monetary autonomy are qualified as *Ambivalent*. In the other study, Angel and McCabe [58] analyze the ethics of payments. Bitcoin is investigated as a payment mechanism alongside of paper money and plastic cards. The authors also address the conflict between bitcoin and monetary policy from the perspective of central banks. In a discussion on coin mining, they argue that profit-motivated miners are no more self-interested than current participants in the financial industry. This raises an interesting issue of whether a system or platform is ethical when participants pursue self-interest. However, blockchain-based cryptocurrencies are neutral even if the miners are motivated by rewards rather than altruist goals. On this issue, Angel and McCabe [58] conclude that bitcoin as a payment is not ethically good nor ethically bad but its uses may be.

Table 3 summarizes the ethical challenges of cryptocurrencies in three areas that differ regarding the scale of their impact. From small to large-scale, coin mining, payment functions, and currency functions are identified.

Table 3: Ethical Issues of Cryptocurrencies

Levels	Impacted range	Stakeholders	Issues
Coin Mining	Miners community	Cryptocurrency miners; Investors; Coin Exchanges	Lack of intrinsic value; Unfairness for late comers; Fluctuation in coin prices; Delay in verification
Payment	Businesses	Business owners; Financial institutions	Money laundry; Criminal abuses; New business models
Currencies	Economies	Central banks; Government; Economic Bodies	Threats to fiat money; Impacts to monetary policy; Network effects in the ecosystem; Lack of regulation and laws; Suspicion of Ponzi scheme

4.3 Ethics of Smart Contracts

Smart contracts are blockchain-deployed programs that perform a predefined set of actions when predefined conditions are satisfied. The contents (i.e., the clauses) of such smart contracts are encoded as *if-then-else* rules. A smart contract consists of contract status information, contents, and detailed rules. Smart contracts can be triggered by external events or other inputs from sources such as information systems or Internet of Things (IoT) systems. Once the inputs satisfy the rules encoded in the smart contract, the contract executes transactions on digital assets or other business logic. The process is automated and enforced by algorithms independent of real-world laws, with authentication and trust being guaranteed by the blockchain. Smart contracts are thus used to automatically change the ownership of targeted digital assets registered on blockchains.

Because the conditions and rules of smart contracts are abstract, they can be used to implement logic and procedures in domains beyond commercial agreements. This opens possibilities for smart contracts to enable automated processes and applications across different areas. Discussion of smart contracts should therefore not be limited to their impacts on commercial contract laws. More generally, social contracts are the foundation for an ideal society based on peer-to-peer, rather than peer-to-government, relationships [59]. Smart contracts provide technologically feasible solutions to implement the universally accepted rules of social activities and open possibilities for new models of governance through new social contracts [60]. The digitalization of social contracts and norms are both challenging and exciting. Updated social contracts are essential in the information age to protect human dignity and fulfill human potentials [15].

4.4 Ethics of Blockchain Decentralization

Decentralization is the core benefit of blockchain applications. Therefore, the ethics of blockchain applications can be better understood in the light of the existing debate on the ethics of the centralization associated with cloud computing. To reduce costs, individuals, organizations, and governments have adopted cloud computing and thus have become dependent on cloud service providers [18]. This centralization trend has clear social benefits, but also raises ethical challenges because it involves surrendering information to the cloud and thus accumulating power in the hands of service providers. This has fueled a debate on the ethics of the centralization of computing [61], which now needs to expand and include the decentralization brought by blockchain. A discussion of the ethical implications of blockchain decentralization however needs to account for two blockchain-specific facts. First, decentralization is not implemented in all blockchain applications. Second, blockchain decentralization brings both advantages and disadvantages. Without a clear understanding of these facts, the ethical implications of blockchain applications cannot be determined. A model of implications of blockchain decentralization appears in Table 4.

Table 4: Implications of Blockchain's Decentralization at Different Levels

Levels	Stakeholders	Implications
Technology stack	Technology provider; Technology community	Failure tolerance; Decentralized data storage; Decentralized authentication
Business activity	Commercial traders; Service providers; Supply chain participants	Trustless ecosystem; Efficiency; Autonomation
Social structure	Governments; Social organizations; Law bodies	Utopian anarchy; Democracy; Intermediary elimination

5. CONCLUSIONS AND FUTURE RESEARCH

This paper proposes an initial analysis on the ethical aspects of blockchain. After reviewing the basic concepts underlying blockchain and its applications, we propose a conceptual model that structures the ethical aspects of four major blockchain application realms: the technology stack, cryptocurrencies, smart contracts, and blockchain decentralization. The fundamental concepts, typical applications, and major ethical impacts are analyzed in detail for each realm.

Blockchain already encompasses a wide range of applications and thus has broad social implications. However, these applications and implications are rapidly evolving as its technological base is still under rapid development. By no means, this paper is a thorough and complete investigation of all ethical issues associated with blockchain and its applications. No single study can address all the ethical problems of blockchain, since problems continue to emerge with the development and adoption of blockchain. Preventing the potential negative consequences of such a game-changing technology requires that research on the ethics of blockchain progress as early and fast as the technology itself.

We hope that this paper can contribute to the awareness and understanding of blockchain's ethical issues among academics and practitioners. This research, we hope, will inspire scholars, professionals, industry leaders, and policymakers to contribute to a systemic understanding of blockchain's ethics. We also hope this paper can serve as an initial roadmap to further research on the ethics of blockchain. Detailed case study and interviews can be conducted in the future based on the research model proposed in this paper. The detailed case studies will help us confirm the factors identified through the literature review and identify any new challenges/risks that companies adopting blockchain are facing. That will help us refine our research model and lay the foundation for more empirical research on the ethics of blockchain.

6. ACKNOWLEDGMENTS

This research is supported by the ACM Special Interest Group (SIG) on Management Information Systems (MIS) research funding (2018-2019).

7. REFERENCES

[1] Nakamoto, S. Bitcoin: A peer-to-peer electronic cash system (2008).

[2] Swan, M. *Blockchain: Blueprint for a new economy.* O'Reilly Media, Inc., 2015.

[3] Underwood, S. Blockchain beyond bitcoin. *Communications of the ACM*, 59, 11 (2016), 15-17.

[4] Tapscott, D. and Tapscott, A. The impact of the blockchain goes beyond financial services. *Harvard Business Review* (May 2016).

[5] Wörner, D. and Bilgeri, D. *The Bitcoin Ecosystem: Disruption Beyond Financial Services?* , City, 2016.

[6] Tapscott, D. and Tapscott, A. *Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World.* Penguin, 2016.

[7] Moor, J. H. The Nature, Importance, and Difficulty of Machine Ethics. *IEEE Intelligent Systems*, 21, 4 (July 2006), 18-21.

[8] Moor, J. H. What Is Computer Ethics? *Metaphilosophy*, 16, 4 (1985), 266-275.

[9] Göbel, J., Keeler, H. P., Krzesinski, A. E. and Taylor, P. G. Bitcoin blockchain dynamics: The selfish-mine strategy in the presence of propagation delay. *Performance Evaluation*, 104 (2016), 23-41.

[10] Treleaven, P., Brown, R. G. and Yang, D. Blockchain Technology in Finance. *Computer*, 50, 9 (2017), 14-17.

[11] Bostrom, N. and Yudkowsky, E. The ethics of artificial intelligence. *The Cambridge handbook of artificial intelligence* (2014), 316-334.

[12] Stahl, B. C. Morality, ethics, and reflection: a categorization of normative IS research. *Journal of the Association for Information Systems*, 13, 8 (August 2012), 636-656.

[13] Davison, R. M. Professional ethics in information systems: A personal perspective. *Communications of the AIS*, 3, 2es (2000), 4.

[14] Mingers, J. and Walsham, G. Toward ethical information systems: the contribution of discourse ethics. *Mis Quarterly*, 34, 4 (2010), 833-854.

[15] Mason, R. O. Four Ethical Issues of the Information Age. *MIS Quarterly*, 10, 1 (March 1986), 5-12.

[16] Floridi, L. Information Ethics, Its Nature and Scope. *ACM SIGCAS Computers and Society*, 35, 2 (June 2005), 3-3.

[17] Langford, D. Ethics and the Internet: Appropriate Behavior in Electronic Communication. *Ethics & Behavior*, 6, 2 (06 1996), 91-106.

[18] Miller, K. W. Ethical Analysis in the Cloud. *IT Professional*, 12, 6 (Nov 2010), 7-9.

[19] Fairfield, J. and Shtein, H. Big Data, Big Problems: Emerging Issues in the Ethics of Data Science and Journalism. *Journal of Mass Media Ethics*, 29, 1 (2014), 38-51.

[20] Mittelstadt, B. D., Allo, P., Taddeo, M., Wachter, S. and Floridi, L. The ethics of algorithms: Mapping the debate. *Big Data & Society*, 3, 2 (2016), 2053951716679679.

[21] Stahl, B. C. Ethics, morality and critique: An essay on Enid Mumford's socio-technical approach. *Journal of the Association for Information Systems*, 8, 9 (September 2007), 479-490.

[22] Doss, E. and Loui, M. C. Ethics and the privacy of electronic mail. *The Information Society*, 11, 3 (1995), 223-235.

[23] Calzarossa, M. C., De Lotto, I. and Rogerson, S. Ethics and information systems — Guest editors' introduction. *Information Systems Frontiers*, 12, 4 (Sep 2009), 357-359.

[24] Conger, S., Loch, K. D. and Helft, B. L. Ethics and information technology use: a factor analysis of attitudes to computer use. *Information Systems Journal*, 5, 3 (1995), 161-183.

[25] Marx, G. T. Ethics for the New Surveillance. *The Information Society*, 14, 3 (1998), 171-185.

[26] Peterson, D. K. Computer ethics: the influence of guidelines and universal moral beliefs. *Information Technology & People*, 15, 4 (2002), 346-361.

[27] Adam, A. Computer ethics in a different voice. *Information and Organization*, 11, 4 (2001), 235-261.

[28] Smith, H. J. and Hasnas, J. Ethics and Information Systems: The Corporate Domain. *MIS Quarterly*, 23, 1 (1999), 109-127.

[29] Haines, R. and Leonard, L. N. K. Situational influences on ethical decision-making in an IT context. *Information & Management*, 44, 3 (2007), 313-320.

[30] Moores, T. T. and Chang, J. C.-J. Ethical Decision Making in Software Piracy: Initial Development and Test of a Four-Component Model. *MIS Quarterly*, 30, 1 (2006), 167-180.

[31] Hansen, J. and Walden, E. The role of restrictiveness of use in determining ethical and legal awareness of unauthorized file sharing. *Journal of the Association for Information Systems*, 14, 9 (September 2013), 521-549.

[32] Taddeo, M. and Vaccaro, A. Analyzing Peer-to-Peer Technology Using Information Ethics. *The Information Society*, 27, 2 (2011), 105-112.

[33] Jones, S. Doing social network ethics: a critical, interdisciplinary approach. *Information Technology & People*, 30, 4 (2017), 910-926.

[34] Bush, V. D., Venable, B. T. and Bush, A. J. Ethics and Marketing on this Internet: Practitioners' Perceptions of Societal, Industry and Company Concerns. *Journal of Business Ethics*, 23, 3 (Feb 2000), 237-248.

[35] Wolf, M. J. and Fresco, N. Ethics of the software vulnerabilities and exploits market. *The Information Society*, 32, 4 (2016), 269-279.

[36] Chatterjee, S. and Sarker, S. Infusing ethical considerations in knowledge management scholarship: Toward a research agenda. *Journal of the Association for Information Systems*, 14, 8 (August 2013), 452-481.

[37] Banerjee, D., Cronan, T. P. and Jones, T. W. Modeling IT Ethics: A Study in Situational Ethics. *MIS Quarterly*, 22, 1 (1998), 31-60.

[38] Holub, M. and Johnson, J. Bitcoin research across disciplines. *The Information Society*, 34, 2 (2018), 114-126.

[39] Hawlitschek, F., Notheisen, B. and Teubner, T. The limits of trust-free systems: A literature review on blockchain technology and trust in the sharing economy. *Electronic Commerce Research and Applications*, 29 (2018), 50-63.

[40] Rimba, P., Tran, A. B., Weber, I., Staples, M., Ponomarev, A. and Xu, X. Quantifying the Cost of Distrust: Comparing Blockchain and Cloud Services for Business Process Execution. *Information Systems Frontiers* (Aug 2018).

[41] Li, X. and Wang, C. A. The technology and economic determinants of cryptocurrency exchange rates: The case of Bitcoin. *Decision Support Systems*, 95 (2017), 49 - 60.

[42] Polasik, M., Piotrowska, A. I., Wisniewski, T. P., Kotkowski, R. and Lightfoot, G. Price Fluctuations and the Use of Bitcoin: An Empirical Inquiry. *International Journal of Electronic Commerce*, 20, 1 (2015), 9-49.

[43] Thelwall, M. Can social news websites pay for content and curation? The SteemIt cryptocurrency model. *Journal of Information Science*, 0, 0 (2017), 0165551517748290.

[44] Mai, F., Shan, Z., Bai, Q., Wang, X. and Chiang, R. H. L. How Does Social Media Impact Bitcoin Value? A Test of the Silent Majority Hypothesis. *Journal of Management Information Systems*, 35, 1 (2018), 19-52.

[45] Avital, M. Peer Review: Toward a Blockchain-enabled Market-based Ecosystem. *Communications of the Association for Information Systems*, 42 (2018), 28.

[46] Ølnes, S., Ubacht, J. and Janssen, M. Blockchain in government: Benefits and implications of distributed ledger technology for information sharing. *Government Information Quarterly*, 34, 3 (2017), 355-364.

[47] Dai, J. and Vasarhelyi, M. A. Toward Blockchain-Based Accounting and Assurance. *Journal of Information Systems*, 31, 3 (2017), 5-21.

[48] Li, Z., Wang, W. M., Liu, G., Liu, L., He, J. and Huang, G. Q. Toward open manufacturing. *Industrial Management & Data Systems*, 118, 1 (2018), 303-320.

[49] Kshetri, N. Potential roles of blockchain in fighting poverty and reducing financial exclusion in the global south. *Journal of Global Information Technology Management*, 20, 4 (2017), 201-204.

[50] Ying, W., Jia, S. and Du, W. Digital enablement of blockchain: Evidence from HNA group. *International Journal of Information Management*, 39 (2018), 1-4.

[51] Gozman, D., Liebenau, J. and Mangan, J. The Innovation Mechanisms of Fintech Start-Ups: Insights from SWIFT's Innotribe Competition. *Journal of Management Information Systems*, 35, 1 (2018), 145-179.

[52] Yli-Huumo, J., Ko, D., Choi, S., Park, S. and Smolander, K. Where Is Current Research on Blockchain Technology?---A Systematic Review. *PLOS ONE*, 11, 10 (10 2016), 1-27.

[53] Agre, P. E. P2P and the promise of internet equality. *Communications of the ACM*, 46, 2 (2003), 39-42.

[54] Allen, C., Wallach, W. and Smit, I. Why Machine Ethics? *IEEE Intelligent Systems*, 21, 4 (July 2006), 12-17.

[55] Bonneau, J., Miller, A., Clark, J., Narayanan, A., Kroll, J. A. and Felten, E. W. *SoK: Research Perspectives and Challenges for Bitcoin and Cryptocurrencies*. City, 2015.

[56] DuPont, Q. The politics of cryptography: Bitcoin and the ordering machines. *Journal of Peer Production*, 1, 4 (2014), 1-10.

[57] Dierksmeier, C. and Seele, P. Cryptocurrencies and Business Ethics. *Journal of Business Ethics* (2016).

[58] Angel, J. J. and McCabe, D. The Ethics of Payments: Paper, Plastic, or Bitcoin? *Journal of Business Ethics*, 132, 3 (2015), 603-611.

[59] Rousseau, J.-J. *The Social Contract and Discourses*. JM Dent & Sons, 1920.

[60] Reijers, W., O'Brolcháin, F. and Haynes, P. Governance in Blockchain Technologies & Social Contract Theories. *Ledger*, 1, 0 (2016), 134-151.

[61] George, J. F. and King, J. L. Examining the computing and centralization debate. *Communications of the ACM*, 34, 7 (July 1991), 62-72.