Understanding Blockchain Technology: Centering Resonance Analysis

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ABSTRACT

The increasing worldwide demands for innovation have augmented the adoption of disruptive technologies such as blockchain for industrial and organizational developments. Blockchain technology has been gaining much interest and has developed to be a fundamental aspect of organizations and one of the most dominant topics in recent academic research. This study attempts to identify the underpinnings of blockchain technologies and the reasoning behind this disruptive innovation. This study uses centering resonance analysis to develop an empirically grounded understanding of the logic for blockchain technologies beyond the obvious, through secondary archived data. Through the content analysis of 172 peer-reviewed published articles, the authors decode seven themes (i.e., politics, performance, added-value, datafication, digital revolution, robotics, and security) through three theoretical frameworks: economic, innovative, and societal perspectives.

KEYWORDS
Blockchain, Centering Resonance Analysis, Text-Mining

INTRODUCTION

Advanced technological developments and innovation are playing significant roles in restructuring and reorganizing societies and industries. Economies are forced to adopt and adapt according to recent progressive trends in technology, digitization, and modernization. Nevertheless, there have been opposing views in the literature concerning the intention and purpose of these advanced technologies.

It has been suggested by Cann (2016) that such technological advancements are leading to a new type of industrial revolution but with a loss of millions of jobs worldwide. Thompson (2016) found that such phenomena create new highly skilled and specialized jobs (i.e., algorithmic and analytical) while replacing the outdated ones. The World Economic Forum stated that technological advancements are a few of the causes behind the loss, shift, replacement, or dislocation of a large number of jobs. On the other hand, such technologies have shown to lead to increased economic growth and development (Grothaus, 2017). Such inconsistencies in the literature have developed to be an interesting avenue to explore in this study.

Studies in innovation show that such technologies are being increasingly deployed and implemented by most large organizations, startups, and FinTechs. Businesses are increasingly adopting innovation into their processes, which in turn encourages large institutions to monitor
their developments (Raymaekers, 2015). Among the recent developments in innovation, blockchain technologies have gained an exceptional interest.

Recently, a growing number of organizations and FinTechs have expressed their intent to enter the blockchain domain. Yet, their interests started shifting from the benefits (e.g., speed, increased efficiency) to the various challenges (e.g., high energy consumption, high processing/operation costs) of blockchain technology. Nonetheless, the underpinnings that inaugurate the benefits and challenges of blockchain technology have not yet been explored in the literature. Against these backgrounds, this study attempts to investigate the underpinnings of blockchain technology and the reasoning behind this disruptive innovation.

This study is conducted through the analysis of anecdotal evidence in the form of published online articles and coding them to extract specific themes. Furthermore, the text-mining method was used to develop an enriched understanding of blockchain technology. The study develops seven themes (i.e., politics, performance, added-value, datafication, digital revolution, robotics, and security) through three theoretical frameworks (i.e., economic, innovative, and societal perspectives) that may provide a “big picture” for understanding the concept of blockchain technology.

The importance of this study is the following. According to a 2019 survey conducted by Deloitte, 53% of respondents consider blockchain as a critical priority for their organizations (10% increase from 2018) (Deloitte, 2019). Yet, because the empirical literature on blockchain technology is still at its infancy, opposing opinions, views, and recommendations have emerged concerning this technology (Husain, Franklin, & Roep, 2020). Thus, this study is the first to address the inconsistencies found in the literature by identifying the underpinnings of blockchain technology. Hence, the starting point of this study is the academic and practical need for navigating the widely predominant blockchain concept. As such, the findings can serve as a general roadmap for tech organizations and FinTech startups in the blockchain domain to pre-identify certain elements that may support or hinder their growth.

The rest of the research is structured as follows: the following section discusses the concepts of disruptive innovation and blockchain technology. These are followed by the methodology section that consists of centering resonance analysis (CRA), text analysis, and themes development. The authors then elaborate on the findings and conclude with a discussion.

THEORETICAL FOUNDATION

Disruptive Innovation

Historically, the tendency to innovate is driven by individual creativity to identify issues, seek solutions, analyze data, build theories, and validate concepts (Amabile, Conti, Coon, Lazenby, & Herron, 1996; McLean, 2005). Innovation is characterized by two main types (i.e., sustaining and disruptive) (Christensen, 2013).

Sustaining innovation does not directly affect any current market or industry. It is defined as the improvement rather than the creation of a new product, service, or technology (King & Baartartogtokh, 2015; Tran, 2008). Disruptive innovation motivates the creation of a new market and business niche by introducing a new concept that dominates the current market. (Christensen, Raynor, & McDonald, 2015; Corsi & Di Minin, 2014). In other terms, sustaining innovation sustains an existing product/service/technology, whereas disruptive innovation stimulates a disruption (replacement or substitution) towards a currently existing product/service/technology. This study investigates the second type of innovation.

A few of the most prominent and emerging technologies with disruptive abilities are ride-sharing, Internet-of-Things, driverless vehicles, autonomous robots, virtual reality, 3D printing, cloud computing, vertical take-off and landing, and blockchain. This study focuses on the blockchain technology.
Blockchain Technology

Blockchain is a developing and potentially disruptive technology that academics and researchers have recently started exploring (Frizzo-Barker et al., 2019). Blockchain is one of the cutting-edge technological progress that is being implemented in businesses to augment productivity and performance. Nevertheless, in the Information systems (IS) discipline, there have been terminological uncertainties and ambiguities concerning the blockchain technology. Numerous definitions, descriptions, and characterizations are found in the literature (see Table 1).

Table 1. Definitions of blockchain in IS literature

| Definition                                                                 | Author                              | Focus          |
|---------------------------------------------------------------------------|-------------------------------------|----------------|
| Blockchain is a tamper-resistant, decentralized database of transactions, consistent across a base of decentralized nodes | Beck, Muller-Bloch, & King (2018)   | Technical      |
| Blockchain is a decentralized platform which contains information about all the transactions ever executed, works on consensus protocols, creates a digital ledger of transactions and allows the participants of the network to edit the ledger in a verifiable, changeless, and secure way | Walton & Dhillon (2017)             | Functional     |
| Blockchain presents a unique packaging of the distributed digital ledger, a decentralized consensus mechanism along with cryptographic security measures | Mohring et al. (2018)              | Technical      |
| Blockchain is a digitized, decentralized, and automated public ledger of all cryptocurrency transactions. These trades are recorded in chronological order with digital traces of all transactions and excluding any central record-keeping | Ai, Han, Wang, & Yan (2016) Ji, Cai, Han, & Beyah (2015) | Functional     |
| Blockchain provides an immutable, append-only public database, which is secured by the computational power provided by miners | Notheisen, Cholewa,. & Shanmugam (2017) Notheisen, Hawlitschef, & Weinhardt (2017) | Technical      |
| Blockchain is a distributed, immutable digital record system that is shared among many independent parties and can be updated only by their consensus | Avital, King, Beck, Rossi, & Teigland (2016) | Technical      |
| Blockchain is a shared digital ledger, which stores peer-to-peer transactions in blocks. In blockchain there is no centralized authority, instead, all transactions are shared | Woodside & Amiri (2018)            | Technical      |
| Blockchain ledger is a record of transactions that is shared across a network of users and individually verified by each participant | Mashatan & Roberts (2017)          | Technical      |
| Blockchain, the technology underlying cryptocurrencies such as Bitcoin, is a distributed ledger technology that enables organizations to engage in transactions without the need for a commonly trusted authority | Mendling, Decker, Hull, Reijers, & Weber (2018) | Functional     |
| Blockchain is a unification of various methods comprising cryptography, algorithms, economic models, and mathematics. It merges peer-to-peer networking and distributed algorithms to resolve the synchronization concerns from outdated distributed databases | Garay, Kiayias, & Leonardos (2015)  | Technical      |
| Blockchain offers participants the opportunity to establish a distributed consensus on a set of shared facts without assuming mutual trust. In its basic form, a distributed ledger is a fixed protocol for adding new events to a log of events | Egelund-Muller, Elsman, Henglein, & Ross (2017) | Functional/Technical |
Thus, numerous meanings of blockchain are found in the IS literature, nevertheless, the authors’ intention is not to address such concerns; instead, this study aims at exploring blockchain technology as a holistic disruptive innovation rather than examining its specific characteristics, usage, or purposes in the professional domains.

Specifically, this study tends to adopt the functional (blockchain’s capabilities and functionality) rather than the technical (systems components) or the functional-technical approaches of blockchain technology (e.g., Mendling et al., 2018; Walton & Dhillon, 2017; Ai, Han, Wang, & Yan, 2016; Ji, Cai, Han, & Beyah, 2015).

Practically, blockchain evolved through three stages (Swan, 2014). Blockchain initially leveraged the concept of cryptocurrencies (mainly Bitcoin) while securing and validating the transactions by using a proof-of-the-work consensus algorithm. At secondary stages, blockchain started supporting smart contracts (in the form of Ethereum) that contributed to a layer of computation logic to the trust infrastructure (i.e., decentralized applications). At later stages, blockchain articulated decentralized principles of governance and justice throughout societies with more advanced algorithms (proof of stake, proof of authority, proof of weight, etc.). As such, blockchain technology is expanding in scale with a noticeable high number of uses within organizational operations, processes (Korpela, Hallikas, & Dahlberg, 2017), applications, and industries (i.e., finance, healthcare, mobile applications, defense, automobiles, etc.) (Suankaewmanee et al., 2017; Barnas, 2017; Tschorsch & Scheuermann, 2016; Linn & Koo, 2016; Chen et al., 2015).

METHOD

This study uses content analysis to evaluate the information. Content analysis is a research method used a) to systematically assess the theme of recorded communications; b) to systematically evaluate and convert texts from qualitative to quantitative data; c) to synthesize texts with a large number of words into smaller categories; d) to recover and examine behaviors, perceptions, and trends; e) to bridge quantitative and qualitative research methods; f) to analyze socio-cognitive and perceptual constructs that are difficult to study via traditional quantitative archival methods; and g) to gather large samples that may be difficult to employ in purely qualitative studies (Krippendorf, 2004; Stemler, 2001; Kolbe & Burnette, 1991).

A detailed methodological road-mapping is presented in Figure 1 that includes the phases of the data collection and the screening-selection processes of the relevant articles. The selected sample mainly focused on blockchain concerning business and economics, information systems, law and governance, and other non-technical domains (e.g., culture, ethics). The publication years of the sample were distributed as follows: 2 papers (1.16%) were published in 2014, 4 papers (2.32%) in 2015, 19 papers (11.07%) in 2016, 36 (20.93%) in 2017, 48 papers (27.90%) in 2018, 55 papers (31.97%) in 2019, and 8 papers (4.65%) in 2020. From the 172 papers, 77% (n=132) were conceptual (concepts, applications, theories, literature), 21% (n=36) were empirical (qualitative and quantitative approaches), and 2% (4) were systematic reviews. The peer-reviewed research outlets are provided in Table 2.
Centering Resonance Analysis (CRA)

Although content analysis is increasingly applied by management researchers, many are unfamiliar with its techniques. This study employs the Centering Resonance Analysis (CRA) technique, a particular form of the content analysis tool. This method is an innovative approach developed to conduct textual content analysis in a semi-automatic, theory-informed, and analytically-driven way.
Yet, despite its robustness, CRA is still relatively unknown and rarely used in management research (Simoes Freitas et al., 2018).

CRA is a sophisticated technique of content analysis methodology (Corman, Kuhn, McPhee, & Dooley, 2002). CRA is chosen to analyze reports because it interprets the meaning of specific texts (Holsti, 1969). It is a form of content analysis tool, suitable for studying formal written communications (Corman et al., 2002). This technique analyzes words and phrases in meaningful ways to form a network, depicting their influence and inter-relationship (Corman et al., 2002). Unlike other methodology tools that only rely on frequency counts of words and phrases with limited significance to the interrelationship between words, CRA creates maps; thus, representing conceptual relationships visually. Unlike other methods, CRA relies on the utilization of linguistic centering theory to determine an important term or expression. CRA does not consider words in segregation but defines their impact building on their centrality in the network of words. In other terms, CRA exploits network perspective and enables the identification of significant terms and practices. Crawdad version 1.2 text analysis system was utilized to perform CRA.

Text Analysis

The online articles were converted into readable text documents. Each sample was processed independently in the CRA software system. The CRA creates network maps of the words for every sampled article and influence values between 0 and 1 are assigned to words. The influence value of 0.01 is considered to be significant, while a value above 0.05 is considered to be very significant (Corman & Dooley, 2006). To better demonstrate this concept, a CRA network map (see Figure 2) and its top influential words (see Table 3) are presented. The Crawdad system parameters were set to identify the 100 most influential and significant words that were common in online articles. The intention was to determine the highly significant words across the pool of 172 articles.

Figure 2. Network maps
To assess the thematic structure of the online articles, exploratory factor analysis (EFA) using principal component analysis with varimax rotation was performed. The eight themes that emerged revealed comprehensible groups of words that provided the foundation for naming the themes and latent coding. According to Neuman (2000), latent coding allows the researchers to analyze the underlying implicit meaning in the text. The secondary latent coding allowed the logical connection of words to themes and further strengthened the face validity of the theme. The developed themes and the related words are illustrated below (see Table 4).

### Table 3. Summary list of most influential words

| Words | Disruptive | Technology | Innovation | Profit | Policy | Risks | Control | Resources | Data | Skills |
|-------|------------|------------|------------|--------|--------|-------|---------|-----------|------|--------|
| Influence value | 0.426 | 0.251 | 0.235 | 0.164 | 0.152 | 0.092 | 0.086 | 0.083 | 0.0675 | 0.0621 |
| Counts of words | 2385 | 1405 | 1315 | 918 | 850 | 515 | 481 | 465 | 378 | 348 |

*Technical terms, brand names, and miscellaneous influential keywords were dropped for adding no significant value (e.g., firms, services, market, management, economy, blockchain, bitcoin, proof of work, etc.)*

### Themes Development

To assess the thematic structure of the online articles, exploratory factor analysis (EFA) using principal component analysis with varimax rotation was performed. The eight themes that emerged revealed comprehensible groups of words that provided the foundation for naming the themes and latent coding. According to Neuman (2000), latent coding allows the researchers to analyze the underlying implicit meaning in the text. The secondary latent coding allowed the logical connection of words to themes and further strengthened the face validity of the theme. The developed themes and the related words are illustrated below (see Table 4).

### Table 4. List of themes and related words

| Politics | Performance | Added value | Datafication | Digital revolution | Robotics | Security |
|----------|-------------|-------------|--------------|--------------------|----------|----------|
| Policy   | Jobs        | Agility     | Algorithm    | FinTech            | E-Systems| Control  |
| Regulation | Efficiency |             | Data analysis| Disruptive innovation| Smart contracts| Cyber-attacks |
| Protocols | Scalability |             | Digital identity| Disruptive innovation| Smart contracts| Cyber-espionage |
| Legalities | Profit maximization | Revenue creation | Information sharing | Scaling | AI |
| Sovereignty | Sustainable | Transparency | Database | Business model | Anonymity |
| Regulation | Effectiveness |             |             | Cryptocurrencies | Algorithms | Authorization |

*Table 4 continued on next page*
DISCUSSION
Positive rather than negative results are often published in academic journals (Kitchenham, 2004). Yet, despite the growing academic interest and business investments in the blockchain technology, the findings showed undesirable consequences of this technology within its broad positive effects. In other terms, the results seem to focus on the challenges lingering behind the benefits of blockchain technology. The emerging themes are not related to practical or managerial aspects, but rather, to the economic, innovative, and societal perspectives. Thus, this study identifies blockchain as a foundational rather than a strictly disruptive technology that creates new grounds for the future of the economic and social systems.

Politics
Findings have revealed a growing trend in blockchain infrastructure applications from cryptocurrencies to many different social, cultural, economic, and political domains (Adams, Parry, Godsiff, & Ward, 2017; Aste, Tasca, & Di Matteo, 2017; Golumbia, 2016; Tapscott & Tapscott, 2016; Swan, 2015). This trend supports the growth of the blockchain ecosystem via the political economy, which raises concerns related to control, smart contracts, legal conduct, sovereignty, governance, and regulation (Herian, 2018).

Performance
Recent studies on blockchain technology support the concept that blockchain integration in organizations expedite productivity, increase quality, and reliability, but are most useful to high-skilled laborers (Marzano, Grewinski, Lizut, & Kawa, 2018). Economists are worried concerning the weakening of middle-skilled jobs and the expansion of low and high skilled jobs. This means that recent technological advancements are mostly at the expense of middle and low skilled workers (Hajkowicz et al., 2016). As such, the workforce would be divided into low-paid and high-paid workers. Furthermore, recent Information Technology (IT) studies (related to robotics, A.I., and automation)
suggest an increase in wages in IT departments by 2020, yet most positions will remain vacant due to a shortage of skilled professionals in such fields (Shewan, 2017).

**Added Value**

Despite the proposed added value of blockchain technology (e.g., agility for regulatory agencies, control for manufacturers, track and trace, and guarantee for traceability and transparency), the findings showed uncertainties in the disruptive potential of blockchain technology. For instance, the instability in digital currencies led to a decrease in blockchain investments, a decrease in the market value of blockchain organizations, and a decline in the newly established blockchain activities. Organizations and investors are challenged by unlocking the real potential of blockchain technology and to understand how to harness the abilities into tangible and sustainable sources of value. As such, businesses remain uncertain about how to identify the building blocks for implementing new standards and to ensure significant earnings from their investments (Bender, Burchardi, & Shepherd, 2019).

**Datafication**

When leveraged properly, datafication can modernize businesses by refining processes that may have been previously implausible. As such, businesses are transformed into hyper-efficient and data-oriented organizations. However, when leveraged improperly, datafication may lead to difficulties in detecting faulty information, duplication of entries, and inappropriate data collection/gathering. The findings showed the positive effect of blockchain datafication, nevertheless, there are risks of unclear data ownership, and sacrificing creativity by depending greatly on algorithmic analysis (i.e., over-datafication and data flooding).

**Digital Revolution**

Despite that the digital revolution has significantly modernized businesses, concerns are raised, such as the emergence of the digital divide (Feranmi, 2018). To some degree, this is because of the lack of proper skills and know-how to efficiently use the technologies, which led to businesses struggling to find sufficient talents. In other terms, there has been a growing gap between the use of blockchain and the required knowledge to operate these technologies because of the lack of understanding about blockchain and the low availability of educational resources.

**Robotics**

Substituting humans with machines, computers, and algorithms has affected a wide variety of professions and businesses. Labor-intensive industries (e.g., production, agriculture, manufacturing) shifted to fully automated and mechanized processes (Acemoglu & Restrepo, 2018). Furthermore, a more recent development was the introduction of industrial robotics that automated numerous manufacturing and production tasks (Graetz & Michaels, 2015).

Therefore, organizations are leveraging the power of blockchain into robotics to create advanced systems with improved capabilities (e.g., creation of smart contracts, robo-platforms, digibots, swarm robotics, robotic hardware, machine learning algorithms) (Degardin, 2018; Castello, 2016). Nevertheless, despite the rapid integration of blockchain technology with robotics, there is not yet a clear understanding of how it could develop (Lopes & Alexandre, 2019). As such, uncertainty still exists in defining the future role of blockchain technology with robotics.

**Security**

Security usually includes data integrity, data confidentiality, and data authentication. The security characteristic is ignored due to the complexity of innovative technologies that include decentralized control, confidentiality, privacy, access control, resource provenance, and autonomy. Thus, blockchain technology has been perceived as the solution to the security issue as it provides reliable and private networks of communication while overcoming weaknesses, possible threats, and attacks. Besides,
there have been reports that blockchain could be used for data abuse detection without the need for a central reporting mechanism (Conoscenti, Vetr, & De Martin, 2016).

Nevertheless, despite that security features make blockchains resistant to attacks, they do not make them immune. Some significant concerns and risks have emerged from the use of blockchain technologies. Concerns are related to endpoint vulnerabilities, public and private key security, vendor risks, untested prototypes/versions at full scale, lack of standards and regulations, and untested codes. Whereas, risks are related to technical, usability, centralization, and regulatory issues.

The disruptive change also produces distrust, uncertainty, and insecurity (Joshi, Han, & Wang, 2018; Andoni et al., 2019). In terms of distrust, the international financial system is built on trust between transacting parties, and the potential anonymity of blockchain hinders that trust (OpenLedger, 2019). In terms of uncertainty, employees are worried about the future of their jobs and their privacy (Enterprise Times, 2018). In terms of insecurity, blockchain is vulnerable to leakage of transactional privacy because of the details, balances, and locations of all public keys are detectable to all users in the network. Thus, leading to low levels of confidentiality (Joshi et al., 2018).

LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

Despite that peer-reviewed journal articles are commonly considered to be the most reliable and rigorous outputs in the academic domain (Klarin, 2020), few limitations are found in these types of studies, such as publication bias, sample selection bias, and the combination of qualitative and quantitative studies in the sample. The authors were able to address these concerns by a) searching comprehensive databases for peer-reviewed papers to achieve a wide selection of results; b) conducting detailed discussions and a pilot search; c) collaborating on each phase of the data collection; and d) discussing any scenarios of ambiguity to reach conclusions.

Building on the findings and limitations of this paper, future studies are encouraged to investigate the concept of blockchain technology with the inclusion of the technical papers that were eliminated during the selection phases. This way, a better conceptualization of this technology will be achieved by reaching a wider audience. The study also suggests examining the “media”, “intrinsic value”, “intellectual rights”, and “brand loyalty” elements of this disruptive technology. The findings showed none-to-little evidence of these characteristics, which proves the need to address these research gaps. Thus, future studies can offer significant contributions to blockchain literature.

CONCLUSION

Blockchain technology is still in its embryonic stages and its possible effects are yet to be clearly understood (Lopes & Alexandre, 2019). Currently, it is rapidly developing through phases of uncertainty (Frizzo-Barker et al., 2019). Therefore, this study attempted to develop a networked map through which to analyze the different underpinnings of blockchain technology. The intention of this study is not to support nor advocate such a technology. Rather, it is a research call to investigate deeper into the role of blockchain technology. Thus, the authors do not make claims that blockchain technology is beneficial or a threat. Rather, the authors encourage scholars and practitioners to critically analyze the often underdeveloped underpinnings of blockchain technology. The challenge is understanding the keystones in defining blockchain technology within the ongoing digitalization of data.

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