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Perceived usefulness, ease of use and user acceptance of blockchain technology for digital transactions – insights from user-generated content on Twitter

Purva Grover[a], Arpan Kumar Kar[a], Marijn Janssen[b] and P. Vigneswara Ilavarasan[a]

[a]Information Systems area, Department of Management Studies, Indian Institute of Technology Delhi, New Delhi, India; [b]Technology, Policy and Management, Delft University of Technology, Delft, Netherlands

ABSTRACT
Although blockchain has attracted a great deal of attention from academia and industry there is a lack of studies on acceptance drivers. This study explores blockchain acceptance by mining the collective intelligence of users on Twitter. It maps blockchain user acceptance drivers to technology acceptance constructs. The analysis shows that users are attracted by security, privacy, transparency, trust and traceability aspects provided by blockchain. On Twitter more discussions on blockchain benefits than on drawbacks. Initial coin offering (ICO) is extensively discussed. The study provides guidelines for managers and concludes by presenting the limitations of the study along with future research directions.

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1. Introduction

Blockchain technology is seen as an emergent disruptive technology by both academia and industry. Academics believe that blockchain will lead changes driven by information and communication technology for the next generation (Kogure et al. 2017). Industry leaders, such as the CEO of IBM, Ginni Rometty, predict that 'What the Internet did for communications, blockchain will do for trusted transactions' (September 2017). A report by Cognizant, a large multinational IT firm, argues that sustaining competitive advantage has been the top driver for blockchain adoption among companies and organisations (Cognizant 2017).

Blockchain is a distributed transaction ledger in a peer-to-peer network (Nakamoto 2008), in which each block contains transaction information and a cryptographic hash of the previous block. Each block is duplicated at multiple nodes within a network (Magazzeni, McBurney, and Nash 2017). The cryptography is used to ensure secure, tamper resistance, authenticated and verifiable transactions (Huckle and White 2016; Nordrum 2017; Lu and Xu 2017; Tai, Sun, and Guo 2016). Each transaction in the network becomes valid only when verified by the participants in the network and when consensus is reached according to the algorithm used. Blockchain was introduced by

CONTACT Purva Grover groverdpurva@gmail.com Information Systems area, DMS, Indian Institute of Technology Delhi, New Delhi, India

Satoshi Nakamoto in 2008 in the white paper 'Bitcoin: a peer-to-peer electronic cash system' (Nakamoto 2008). Bitcoin was the first application of blockchain. Blockchain innovated new ways of data storage and sharing (Cuccuru 2017), transaction management (Cuccuru 2017) and digital asset transfers (Kiviat 2015). Applications based on blockchain have the potential for transforming fields such as agriculture (Manski 2017); banking (Dai and Vasarhelyi 2017); business and management (White 2017); finance (Dai and Vasarhelyi 2017; Manski 2017; Scott, Loonam, and Kumar 2017; Tang et al. 2017); capital markets (Tang et al. 2017); insurance (Dai and Vasarhelyi 2017); services (Dai and Vasarhelyi 2017; Manski 2017); governments (Manski 2017; Tang et al. 2017); logistics (Van Engelenburg, Janssen, and Klievink 2017), high-tech enterprises (Tang et al. 2017); and the energy internet (Tai, Sun, and Guo 2016).

Blockchain has gained a lot of attention from both academia as well as industry and is seen as being just as revolutionary as the Internet (Dai and Vasarhelyi 2017). However, evidence to back up such statements has not yet been published. This study addresses this literature gap by exploring blockchain acceptance among users. The empirical methods such as surveys cannot be used for exploring blockchain acceptance among users because of the following reasons: firstly, blockchain is an upcoming technology and at present inadequate expertise exists, and it is difficult to find a representative sample of the collective understanding worldwide. Secondly, blockchain discussion may involve different actors (i.e. users, regulators, developers, operators and many more) which are hard to target. Thirdly, for such emergent technology, respondents would have biases based on limited exposure in ongoing projects at individual level (Hong and Page 2004) and thus the survey method would ignore diversity in opinions and the multiple perspectives of the different actors, leading to inaccurate observations (Choi and Pak 2005).

Therefore to explore this research objective, the collective intelligence was mined for the following reasons. Firstly, when dealing with an emergent technology like blockchain, there are only a few people who have a detailed understanding of the technology, so we needed to study a larger pool of people who know at least something about the technology. Secondly, since the applications built on blockchain involve different actors such as users, regulators, developers and operators, we needed to include *diverse users* in terms of experiences, training and preferences. Diverse perspectives improve understanding, as shown by the *diversity trumps ability theorem* (Hong and Page 2004), and helps us to make accurate predictions as shown by the *diversity prediction theorem* (Page 2007). Collective intelligence of the users on blockchain technology acceptance can be mined through sociotechnical platforms.

Sociotechnical platforms refer to platforms supporting the interactions between humans (social component) and machines (technology) (Cooper and Foster 1971). Grover, Kar and Davies (2018b) found that data captured on sociotechnical web platforms can help in understanding the human nature and technology together. Technology discussions on sociotechnical platforms can influence, control and shape users technology acceptance levels. In this digital era, sociotechnical platforms become an integral part of understanding the human society at large. Popular sociotechnical web platforms may include Facebook, Twitter, Linkedin and ResearchGate. These platforms provide an environment accessible to all individuals across the globe. Social media often stimulate interactions among users to discuss ideas. Facebook is the largest social networking platform, worldwide with the largest number of the users (Kim and Cha 2017). LinkedIn is the world's largest professional networking site. ResearchGate is used in academics by scientists and researchers for sharing research articles (Van Noorden 2014). Whereas, Twitter is the microblogging platform.

Different sociotechnical web platforms focus on enabling different functionalities. Facebook is used more for self-presentation, while LinkedIn is used more for self-promotion (Chae 2018). Similarly, people use Twitter for news and commenting rather than presenting themselves (Opitz, Chaudhri, and Wang 2018). Entertainment had been the primary motivations for using Facebook (Kim and Cha 2017). For using LinkedIn among users, professional advancement and self-presentation had been the primary motivation. There are hardly any restrictions on content access on Twitter, whereas Facebook and LinkedIn content distribution is focussed on their own social network (Sundararajan et al. 2013). Messages posted on Twitter are publicly available. Twitter had been stated as a social broadcasting tool in the literature (Sundararajan et al. 2013). This study investigates technology acceptance by diverse users, regulators, developers, operators and users, which is not commonly presented on ResearchGate. On basis of the orientation (i.e. self-presentation and networking) and due to restriction on content access, Facebook and LinkedIn cannot be used for mining the collective intelligence on blockchain technology. Hence, Twitter had been used to examine user acceptance of blockchain technology. Twitter satisfies the conditions required for collective intelligence. Firstly, Twitter is able to aggregate millions of disparate ideas (Brabham 2008) through hashtags (Chae 2015). When users on Twitter add content by tagging hashtags, this implies that they have some level of interest and expertise on the concept. Secondly, Twitter has evolved as a tool for information sharing and dissemination purposes over a period of time (Hughes and Palen 2009). Thirdly, Twitter content already has been used for examining public opinions related to technology (Runge et al. 2013). Fourthly, Twitter allows geographically dispersed experts in academia and industry to communicate with each other (Runge et al. 2013). Fifthly, the online medium helps us present the big picture of emerging technologies by focusing on applications, policy and social implications (Cacciatore et al. 2012). Finally, social media data gives a glimpse of spontaneous communication (Runge et al. 2013). Ma and McGroarty (2017) pointed out that Twitter harness the crowd thinking by engaging disparate individuals for improving decision-making capabilities. Tang (2018) found that user-generated content on Twitter related to products and brands can be used for predicting the sales at the firm level and pointed out that the predictive power depends on the wisdom of the crowd. Literature shows that a user's participation on Twitter during disaster management can act as human sensors (Ogie et al. 2018). This study explores blockchain acceptance among users by mining the collective intelligence of user-generated content on Twitter. The study focuses on three interrelated research questions (RQ):

RQ1 – What are the primary characteristics of blockchain? How have these characteristics been discussed on Twitter?

RQ2 – What are the primary use cases of blockchain? How have these use cases been discussed on Twitter?

RQ3 – What are the dominant benefits and drawbacks of blockchain technology? How have these benefits and drawbacks been discussed on Twitter?

For the first part of RQ1, RQ2 and RQ3, academic literature as suggested by Glenn (2015) was consulted in order to list the primary characteristics, primary use cases, benefits and drawbacks of blockchain. Subsequently, these lists were used for building the hypotheses H1, H2 and H3 within the Twitter ecosystem.

Tweets containing the term '#blockchain' were extracted for two months between 1 January 2018 and the end of February 2018. This period has been chosen for data extraction because various organisations had indicated the blockchain will be significant for their domain in 2018 (Johnmar, 2018) and blockchain has reached its disillusionment phase according to Gartner hype cycle for emerging technologies. The study assumed that tweets tagged with '#blockchain' had been posted by the humans only and not by bots. Between 4,000 and 6,000 tweets per day were extracted. The discussions on use cases, benefits and drawbacks were tracked on a daily basis, while characteristics were tracked in the top 80% shareable tweets according to the Pareto principle (i.e. 80/20).

The remaining sections are organised as follows: Section 2 focuses on the theoretical basis and hypothesis development. Section 3 illustrates the research approach used for the study. Section 4 gives an analysis of tweets surrounding blockchain technology. Section 5 illustrates discussions of blockchain concerning perceived usefulness (blockchain characteristics), perceived ease of use (blockchain use cases), attitude towards use (blockchain benefits) and external variables (blockchain drawbacks) affecting blockchain usage. The paper concludes by presenting the limitations of the study along with future research directions. It also includes implications for practice.

2. Theoretical basis and hypothesis development

Subsection 2.1 gives a brief presentation of the concept of collective intelligence and crowd wisdom on Twitter. Subsections 2.2, 2.3 and 2.4 discuss the characteristics, use cases, benefits and drawbacks of blockchain as shown in academic literature. Subsection 2.5 presents the technology acceptance model for blockchain technology.

2.1. Collective intelligence and crowd wisdom

Twitter has the potential of capturing collective intelligence from a large pool of users. Collective intelligence has been defined as the meeting of the minds on the internet for validating the ideas of the individuals (Gregg 2010; Kapetanios 2008). Glenn (2015) pointed out that collective intelligence could be the next big thing in the information technology ecosystem. Collective intelligence can facilitate better decision-making (Kornrumpf and Baumöl 2013). The literature also indicates that the combined knowledge of thousands of individuals made independently is more robust and accurate, especially when the domain is new and evolving (Page 2007). The biggest example of the collective intelligence of the people is when they collectively choose their government representatives for their nations (Grover et al., 2018a).

Collective intelligence relies on user participation and connectionism. Users can be knowledge creators, knowledge consumers, software creators, problem solvers and learners (Kapetanios 2008). To facilitate and connect users across the globe, a platform is needed (Glenn 2015) such as Twitter. The way in which blockchain users add their collective intelligence to Twitter is shown in Figure 1. Connections among and between users help in learning, discussing and sharing and thus add to the knowledge surrounding blockchain (Cachia, Compañó, and Da Costa 2007; Senadheera, Warren, and Leitch 2017), thereby pushing the frontiers of knowledge on this emerging technology and impacting the practice.

The biggest advantage of collective intelligence is that social consensus mitigates conflicts and biases so that a clear picture of how users perceive the technology emerges. The literature indicates collective intelligence has been used by both academia and industry (Gregg 2010; Kapetanios 2008; Zhao and Zhu 2014, Joseph et al., 2017).

The wisdom of the crowd has been defined in the literature as the process of taking a collective opinion on an idea by a group of individuals rather than a single expert (Yi et al. 2012). The crowd as a whole has access to far more data than a single expert (Ma et al. 2015). Crowd wisdom helps to generate feasible, robust and accurate solutions (Heiko et al. 2016). Collective intelligence of the users on blockchain is present on Twitter, and there is a need to extract crowd wisdom from this. Figure 2 illustrates the process of extracting crowd wisdom on blockchain characteristics, use case, benefits and drawbacks from the intelligence present on Twitter. We used the 'four stages' research approach – capture, analyse, visualise and comprehend – to extract the crowd wisdom from the collective intelligence present on Twitter described in Section 3.

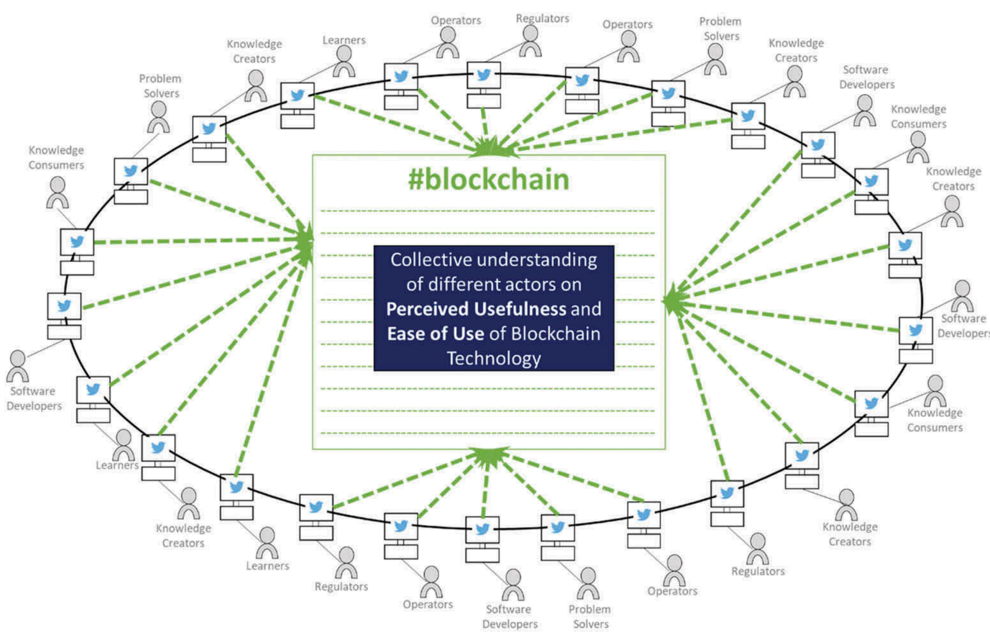

Figure 1. Collective intelligence of different actors on blockchain technology.

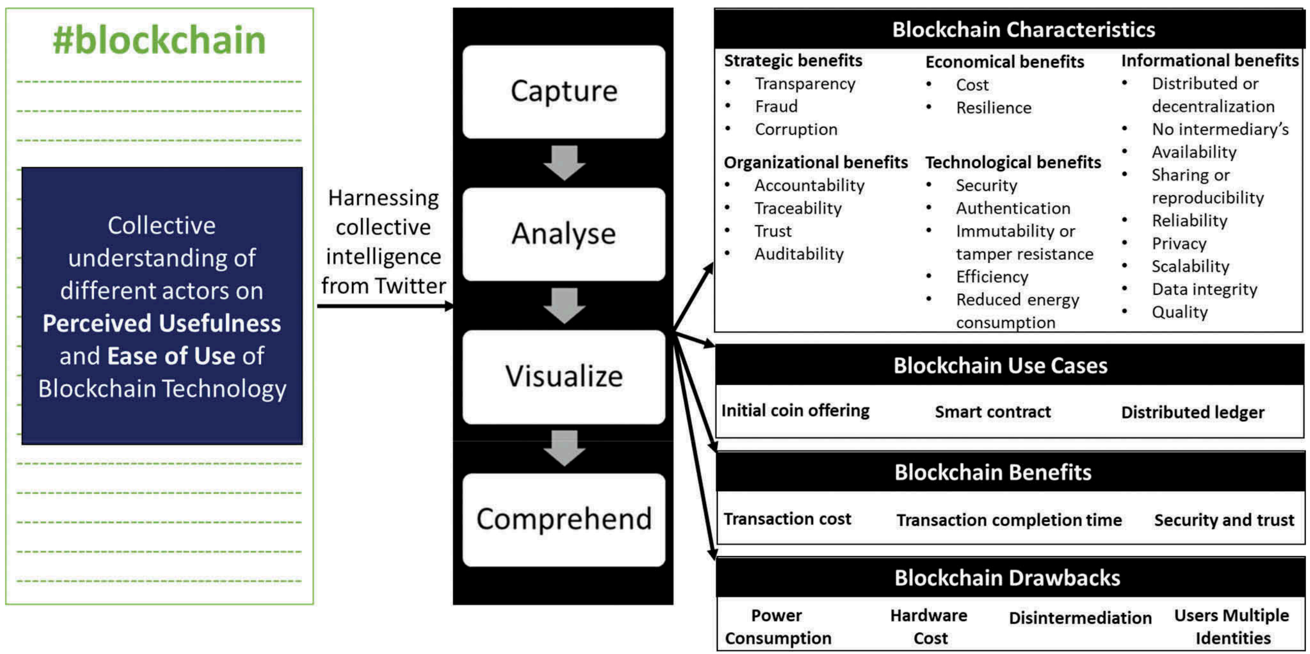

Figure 2. Process of harnessing crowd wisdom from intelligence present on Twitter.

2.2. Blockchain characteristics

Perceived usefulness is about a person's belief that job performance can be enhanced by using a particular technology (Davis, Bagozzi, and Warshaw 1989). The technology considered in this study is blockchain, and the job in question is the digital transaction. Perceived usefulness focuses on the following items: (a) the efficiency, performance, effectiveness, quality, ease and productivity of digital transaction; and (b) the need and usefulness of blockchain compared to existing technologies. Perceived usefulness is significantly correlated to usage (Davis 1989). In RQ1 we investigate the perceived usefulness of blockchain in terms of characteristics and the way these characteristics have been discussed within a virtual community of users.

RQ1: What are the primary characteristics of blockchain? How have these characteristics been discussed on Twitter?

The key characteristics of blockchain are discussed extensively in the literature; a brief explanation of these characteristics is shown in Table 1. However, the literature does not indicate which characteristics are perceived as more useful for digital transactions, and it is this gap in the literature that the present study is investigating using the collective intelligence of Twitter users.

An earlier literature study attempted to map blockchain characteristics to potential benefits in different domains such as strategic, organisational, economic, informational and technological categories (Ølnes, Ubacht, and Janssen 2017). The strategic category

Table 1. Characteristics of the blockchain technology.

Blockchain characteristics	Reference from literature	Implications
Decentralisation	Cuccuru (2017); Khaqqi et al. (2018); Kogure et al. (2017); Seidel (2018);	• Distributed trust • Improves coordination
Immutability	Huckle and White (2016); Nordrum (2017) Lu and Xu (2017); Tai, Sun, and Guo (2016);	• Protects records • Proof of truth
Trust	Kiviat (2015); Seidel (2018); Lu and Xu (2017);	• Solves the illusory problem of a network
Transparency	Bradbury (2015); Dai and Vasarhelyi (2017); Goertzel, Goertzel, and Goertzel (2017);	• Improves accountability • Reduces fraud
No Intermediaries	Larios-Hernández (2017); Kim and Hong (2016); Kshetri (2017); Ying, Jia, and Du (2018);	• Reduces dependencies • Reduces overhead cost • Instant transactions
Sharability	Pazaitis, De Filippi, and Kostakis (2017); Yue et al. (2016); Zhang, Xue, and Huang (2016)	• Decentralised cooperation
Privacy	Cuccuru (2017); Ouaddah, Abou Elkalam, and Ait Ouahman (2016); Yue et al. (2016)	• Control access • Users anonymity
Security	Cuccuru (2017); Ouaddah, Abou Elkalam, and Ait Ouahman (2016); Yue et al. (2016)	• Data store in encrypted format
Authentication and Authorisation	Bradbury (2015); Cuccuru (2017)	• User verification • Access rights • Controlled access
Traceability	Benchoufi, Porcher, and Ravaud (2017); Lu and Xu (2017)	• Improves rectification process • Source identification
Auditability	Huckle and White (2016)	• Enhance credibility
Data Integrity	Peck (2017); Yue et al. (2016)	• Accuracy & consistency
Efficiency	Kshetri (2017); Nordrum (2017); Ying, Jia, and Du (2018)	• Automatic processing

focused on transparency, fraud and corruption. The organisational category focused on accountability, traceability, trust and auditability. The economic category focused on cost and resilience. The informational category focused on distributed or decentralised, no intermediaries (reducing human errors), availability, sharing or reproducibility, reliability, privacy, scalability, data integrity and quality and the technological category focused on security, authentication, immutability or tamper-resistance, efficiency and reduced energy consumption.

We can ask whether the users' perceived usefulness regarding blockchain is due to strategic, organisational, economical, informational and technological benefits. If the answer is yes, does the perceived usefulness of users lean more towards either of the strategic, organisational, economical, informational and technological categories or is it equal for all aspects? We put forward the following hypothesis for this:

H1: All potential benefits of blockchain (clustered under strategic, organisational, economic, informational and technological characteristics) are discussed equally on Twitter.

$$\mu_{strategic} = \mu_{\text{organisational}} = \mu_{\text{economic}} = \mu_{informational} = \mu_{technological}$$

2.3. Blockchain use cases

The perceived ease of use refers to the degree to which a person believes that using the technology will be effortless. The easier the system, the greater the likelihood of it being adopted by the users (Davis 1989). The perceived ease of use includes the following items: (a) physical and mental effort needed; (b) understandability of the use cases; (c) ease of learning for operating various usages; (d) operational efficiency of the use case in terms of error-proneness, controllability, unexpected behaviour; and (e) user-friendliness in terms of ease of remembering and guidance. The perceived ease of use is regarded as a secondary determinant in the technology acceptance (Davis 1989). RQ2 investigates perceived ease-of-use cases of blockchain technology.

RQ2: What are the primary blockchain use cases? How have these use cases been discussed on Twitter?

The three use cases highlighted in literature are: (a) initial coin offering (ICO); (b) smart contract; and (c) distributed ledger. The literature evidences along with their impacts are shown in Table 2. The subsequent subsection gives a brief overview of blockchain use cases.

2.3.1 Initial coin offering

In 2008, Satoshi Nakamoto introduced the idea of electronic cash transfer within a peer-to-peer online network without intermediaries by generating timestamp and immutable transactions records (Nakamoto 2008). Bitcoin is an electronic digital currency which can be traded in the peer-to-peer network through open source software, built on blockchain technology (Savelyev 2017). It is the first and most popular crypto-currency (Hayes

Table 2. Blockchain use cases.

Use Case	Instances	Literature Evidence	Impact
Initial coin offering	Bitcoin – peer to peer trading	• (Hayes 2016) • (Nakamoto 2008) • (Savelyev 2017) • (Tschorsch and Scheuermann 2016)	• Removal of financial intermediaries • Transaction tracking • Across border transaction • Speedy transaction completion time • Open economy
	Crowdsource utility credits	• (Kshetri 2017)	
	Donation platforms	• (Kshetri 2017)	
Smart contract	Legal contracts	• (Dai and Vasarhelyi 2017) • (Magazzeni, McBurney, and Nash 2017)	• Automatic monitoring • Trusted network • Easy auditing of transactions • Control access • Reducing overhead transaction cost • Self-enforceability • Decentralisation
	Principal-agent issues	• (Shermin 2017)	
	Medical data storage (e.g. MeDShare system; OmniPHR)	• (Roehrs, Da Costa, and Da Rosa Righi 2017; Xia et al. 2017)	
	Patient consent workflow	• (Benchoufi, Porcher, and Ravaud 2017)	
	Smart property	• (Zhang and Wen 2017)	
Distributed ledger	Product Tracing	• (Huang et al. 2017)	• Community information sharing • Temper resistance/Immutability • High availability • Real-time tracking
	Online shipment tracking	• (Wu et al. 2017)	
	Electricity transactions	• (Tai, Sun, and Guo 2016)	
	Record keeping	• (Anjum, Sporny, and Sill 2017)	
	Asset ownership	• (McConaghy et al. 2017)	

2016). Using Bitcoin enables criminal activities such as money laundering, terrorism financing, digital ransomware, weapons trafficking and tax evasion to be easily tracked (Ducas and Wilner 2017).

The key features of Bitcoin are: (a) anonymity (Bailis et al. 2017); (b) algorithm-based computation of value; (c) absence of single administrator of transactions; and (d) resilience to data manipulations from outside (Huckle and White 2016; Nordrum 2017; Lu and Xu 2017; Tai, Sun, and Guo 2016; Savelyev 2017). The value of the crypto-currency is dependent on: competition level among producers within a network; production rate; and algorithm complexity (Hayes 2016). The Bitcoin exchange rate depends on the following: (a) technology factors such as public recognition and mining; (b) economic factors such as money supply, GDP, interest rate and inflation; (c) Bitcoin economy such as supply, number of transactions and their value; and (d) market activity such as trading volume and volatility (Li and Wang 2017). The digital currency can be used for collecting donation and crowd-sourced funds (Kshetri 2017).

2.3.2 Smart contract

A smart contract is a self-executing digital transaction (Werbach and Cornell 2017). It stores predetermined criteria and rules for a contract and automatically verifies the same, resulting in subsequent execution of the terms (Cuccuru 2017). This is done within a decentralised ecosystem using a cryptographic mechanism (Werbach and Cornell 2017). Some characteristics of the smart contract (Savelyev 2017) are: (a) electronic in nature; (b) software implemented; (c) provides increase certainty; (d) conditional in nature; and (e) self-performing and self-sufficient. Smart contracts as a way to automate performance may open new business areas in the future (Püttgen and Kaulartz 2017). Using smart contracts will minimise: (a) online fraud risk; (b) uncertainty; and (c) monitoring expenses (Cuccuru 2017). It will also keep an exhaustive record of transaction history. The main challenges are understandability, rigidity by code and decentralisation (Cuccuru 2017).

The smart contract has the potential for (a) replacing legal contracts (Magazzeni, McBurney, and Nash 2017); (b) automatic monitoring of the accounting process (Dai and Vasarhelyi 2017); (c) accelerating insurance processes (Püttgen and Kaulartz 2017); (d) making patient consent workflow easier and flexible (Benchoufi, Porcher, and Ravaud 2017); and (e) solving principal-agent issues (Shermin 2017). There are challenges in replacing contract law by smart contracts (Savelyev 2017). An example of a leading smart contract platform (Bailis et al. 2017) is Ethereum, developed by ConsenSys. The financial sector has been the most dynamic area for smart contract experimentation (Cuccuru 2017). More than 80 global financial institutions have partnered with the R3 consortium for a smart contract conceptual framework, Corda (Magazzeni, McBurney, and Nash 2017).

2.3.3 Distributed ledger

Distributed ledgers allow content to be written to the blocks if – and only if – the data gets consensus from other users present in the network. Blockchain supports various consensus algorithms, such as proof of work; proof of stake; proof of activity; proof of burn; proof of capacity; and proof of elapsed time (Coindesk 2017). Cryptographic methods can be used for encrypting, authorising and linking blocks (Magazzeni, McBurney, and Nash 2017). The shared ledger is stored locally on each of the participants' machines (Tai, Sun, and Guo 2016). Changes in the block require consensus in a distributed multi–stakeholder network for updating. Once a record is written in the database, it is impossible to erase (tamper resistant).

The Blockchain will evolve in future as a distributed computing platform (Anjum, Sporny, and Sill 2017; McConaghy et al. 2017) and can be used in many domains. A validated, real-time shipment tracking system can be built using a set of private distributed ledgers along with a public blockchain ledger. This can be used by the supply chain industry to support data flow across various distribution phases (Wu et al. 2017). Blockchain can be used for owning a digital artwork and subsequently using it for tracking, characterising and exchanging value (McConaghy et al. 2017). Blockchain technology can act as an information system within a peer-to-peer energy market (Mengelkamp et al., 2018) along with dynamic pricing (Peck and Wagman 2017).

In the light of the above, Hypothesis 2 investigates the distribution of discussions on blockchain use cases among users on Twitter, including how they feel about the technology through sentiment scoring. Ma and McGroarty (2017) had pointed out classifying the message on the sentiment scores enables us to predict the market for the use cases.

H2: The distribution of discussion on blockchain use cases, initial coin offering, smart contract, and distributed ledger is similar on Twitter in the study time frame.

2.4. Blockchain benefits and drawbacks

Earlier, Davis (1989) highlighted the following points with respect to the adoption of information and communication technology (ICT): (a) users are willing to face operational difficulty of a system that provides them needed functionality; (b) cost-benefit paradigm is relevant to both perceived usefulness and ease of use; and (c) decision-makers can alter their strategies as task complexity changes. Acceptance of the technology depends on three factors, perceived usefulness, perceived ease of use and attitude toward use (Taherdoost 2018). Perceived usefulness and perceived ease of use have a considerable impact on attitude toward use. In technology acceptance sometimes other factors such as external variables had been considered. External variables include user training, system characteristics, user participation in design and the implementation process nature (Taherdoost 2018). RQ3 investigates benefits and drawbacks of blockchain technology and how benefits and drawbacks were discussed within a virtual community of users.

RQ3: What are the benefits and drawbacks of blockchain technology? How have these benefits and drawbacks been discussed on Twitter?

Blockchain can transform the ICT field by: (a) reducing overhead expenditure for each transaction (Cohen, Samuelson, and Katz 2017; Kshetri, 2017; Shermin 2017); (b) supporting speedy transactions completion time (Cohen, Samuelson, and Katz 2017); and (c) providing security and trust (Kogure et al. 2017). The security and trust provided by the blockchain architecture help the systems in reducing corruption, fraud and bureaucracy within their ecosystems (Kshetri, 2017; Shermin 2017).

Blockchain provides these benefits, but the implementation of blockchain in real time is not without challenges: (a) power consumption (Cocco, Pinna, and Marchesi 2017; Fairley 2017); (b) hardware costs (Cocco, Pinna, and Marchesi 2017; Fairley 2017); (c) disintermediation of central authority/middleman/intermediary (Adams et al. 2017; Kshetri 2017); (d) multiple identities (Alabi 2017); and (e) ransomware risk (Kshetri and Voas 2017). Power consumption and hardware costs can be included under system characteristics in external variables. Disintermediation of users and multiple identities can be included under user participation in external variables. Researchers have raised concerns regarding cost, time, security, trust, power, hardware, intermediaries and identity while working on blockchain applications.

There is no evidence in the literature whether prospective users are discussing the benefits or drawbacks related to blockchain. Therefore, hypothesis H3 proposes that there is no statistically significant difference between the discussions of benefits and drawbacks of blockchain implementation among Twitter users.

H3: The distribution of discussions on blockchain benefits and blockchain drawbacks are similar on Twitter across the time frame of the study.

2.5. Technology acceptance model for blockchain

The user adoption of a system depends on its functionality performance and operational complexity (Davis 1989). Therefore, to develop the hypothesis, concepts from the technology acceptance model (TAM, Davis, Bagozzi, and Warshaw 1989) like perceived usefulness, perceived ease of use, attitude towards use and external variables have been used as the guiding theoretical lens (Taherdoost 2018). Davis (1989) highlighted that perceived usefulness and perceived ease of use are two determinants of the use of ICT. Perceived usefulness measures the belief of a person that using a system will help him/her to perform their job better (Corkindale, Ram, and Chen 2018), whereas perceived ease of use measures belief of a person that using a system will be free from effort. The attitude towards use tries to take into account the person's attitude and internal beliefs regarding the technology. The external variable takes individual differences, situational constraints and managerially controllable interventions into consideration.

On the basis of the literature (Davis 1989; Davis, Bagozzi, and Warshaw 1989), we mapped (a) the perceived usefulness of the blockchain to the characteristics of blockchain; (b) the perceived ease of use to the sentiment score of use cases among users on Twitter; (c) the attitude toward use to the benefits of blockchain; and (d) the external variables to drawbacks of blockchain in Figure 3. The external variables consider factors influencing the users' or organisations' adoption of blockchain technology.

Given the above, we proposed the technology acceptance model (Davis, Bagozzi, and Warshaw 1989) for blockchain, with four factors – perceived usefulness, perceived ease of use, attitude towards use and external variables. To answer RQ1, RQ2, and RQ3, we examined tweets using social media analytics (Chae 2015; Fan and Gordon 2014) along with data mining and statistical approaches (see Section 3).

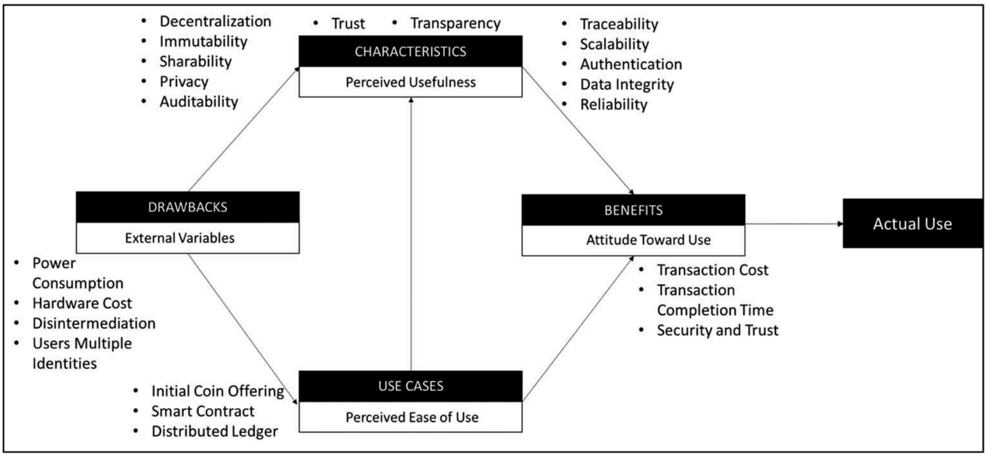

Figure 3. Blockchain technology acceptance for digital transactions.

3. Research approach

Sociotechnical platform has been used for different purposes in society such as: (a) investigating word of mouth in online communities (Cho and Chan 2017; Senadheera, Warren, and Leitch 2017; Song, Jamous, and Turowski 2018; Shan and Lin 2017; Tse et al. 2018; Wang and Guo 2017); (b) opinion mining (Moe and Schweidel 2012; Grover et al. 2018a; Ravi and Ravi 2015); (c) information gathering (Grover, Kar, and Davies 2018b; Senadheera, Warren, and Leitch 2017); and (d) communication purposes (Corkindale, Ram, and Chen 2018; Shan, Ren, and Li 2017). User-generated content exhibits a stronger impact than market-generated content on user behaviour (Goh, Heng, and Lin 2013) and gives less biased, deeper and better understanding by presenting the true state of technology acceptance (Poria et al. 2014). For this reason, we used Twitter data to summarise user acceptance of blockchain technology.

The social media analytics framework is suggested by Fan and Gordon (2014) for analysing social web data. The framework tries to explain how data can be extracted and analysed in three stages: capture, understand and present. However, the framework lacks a provision for showcasing what the outcome of the analysis indicates and signifies. Therefore, this study proposes a new four-stage research approach for working with data – capture; analyse; visualise; and comprehend, for analysing and deriving insights and discussing the implications and significance (Figure 4).

For RQ1 and to validate H1, we mapped the characteristics within tweets using manual content analysis (Kassarjian 1977). The bar chart demonstrates the frequency of the characteristics within the tweets. These characteristics are clustered into categories of benefits (Ølnes, Ubacht, and Janssen 2017). Analysis of Variance (ANOVA) was applied over the frequency of the characteristics to statistically validate the discussions on blockchain. The information flow network is used to visually depict the information flow of blockchain benefits across the network. The results of blockchain characteristics are presented in Section 4.1.

For RQ2 and validating H2, we identified the tweets containing use cases hashtags. The use cases hashtags that occurred in the top 100 dominant hashtags were

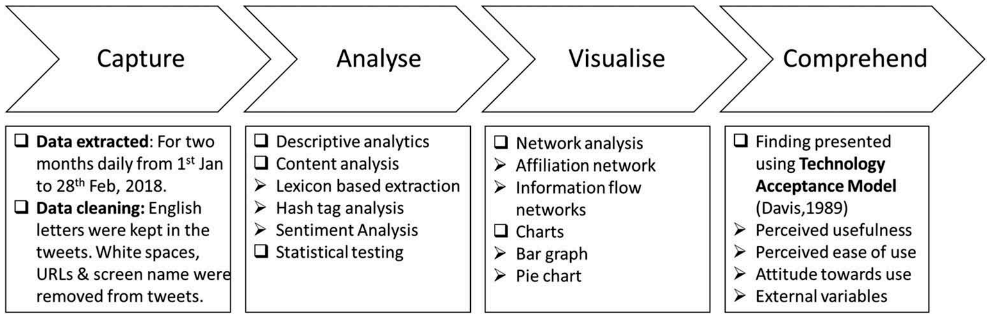

Figure 4. The research approach followed for the study (Capture, Analyse, Visualise, and Comprehend).

selected for further analysis. The frequency of the tweets related to use cases hashtags was computed on a daily basis and the results presented in bar and pie charts. As the distribution of discussions on use cases did not satisfy normality and homogeneity tests, a non-parametric test, the Kruskal–Wallis H test was applied. We made a sentiment analysis of the use cases tweets can provide an overview of users' perception, opinion and attitudes (Mishra and Singh 2018) concerning blockchain use cases and their associated features. For sentiment analysis, we took a list of positive and negative words from the literature (Hu and Liu, 2004; Liu, Hu, and Cheng 2005). The list of the positive and negative words was carefully examined and includes all the positive and negative words related to blockchain technology we encountered.

A sentiment score for each tweet based on the number of positive and negative words in the tweet was computed. Initially, the sentiment score for all tweets was assigned to zero. For each positive word in a tweet, +1 had been added to increase the sentiment score. For each negative word in a tweet −1 had been added to decrease the sentiment score. For each neutral word in a tweet 0 had been added to sentiment score. This process has been adopted from Mishra and Singh (2018). If the sentiment score of a tweet was less than 0, this indicates a negative tweet (more number of negative words for a use case in the tweet); for a value greater than 0, the tweet is positive (more number of positive words for a use case in the tweet); and for a value equal to 0, the tweet is considered as neutral (no positive and no negative word just a query relating to use case; or equal number of positive and negative words, presenting the ambiguous scenario of the users towards the use case). The results are presented in Section 4.2.

For RQ3 and to validate H3, we used lexicon-based extraction to locate tweets related to benefits and drawbacks. The frequency of tweets related to benefits and drawbacks is presented using bar charts. To statistically validate the distribution of discussion on blockchain benefits and drawbacks, we used the Mann Whitney test. The results of this are presented in Section 4.3.

Out of the four stages, in the first stage (capture), we extracted data on a daily basis from Twitter. A mean daily average of 5,784 tweets was extracted. In total, 341,309 tweets were extracted with 35 parameters which included both user and tweet attributes. The user attributes include information for the user such as name, location, description, joining date, followers, following, like, lists and moment count. The tweet attributes contain information related to tweets such as creation time, content, language, location (geo-coordinates), retweet, like and reply attributes.

As a tweet is an informal unstructured content consisting of text, images, hyperlinks, hashtags and other media, cleaning was required. Firstly, anything other than English letters was removed. Secondly, all the extra white spaces were removed. Thirdly, all the URLs were removed. Fourthly, references to other screen names in the tweets were removed.

In the second stage (analyse), we applied descriptive analytics, content analysis (Chae 2015) and statistical testing to the tweets to derive useful information. The descriptive analysis focused on descriptive statistics, such as the number and types of tweets, number of unique users, hashtags and @mention in the tweets.

We used content analysis to extract the semantic intelligence from the text data. This uses natural language processing and text mining (Kayser and Blind 2017) to retrieve the information from text data (Kassarjian 1977). The content analysis includes such methodology as lexicon-based extraction, hashtag analysis, topic modelling and content analysis.

In the third stage (visualise), we visually depicted the connection among users on Twitter using the networks (Stieglitz et al. 2014). The flow of information across the network was visualised using the network diagram. The networks analysis helped us identify communities in a network. The users were clustered on the basis of their opinions (Abascal-Mena, Lema, and Sèdes 2015). In addition to network charts, information is shown in bar and pie charts.

In the fourth stage (comprehend), the findings of the social media analytics were mapped and presented using technology acceptance theory (Davis, Bagozzi, and Warshaw 1989). On the basis of the mapping, the discussion was made for blockchain perceived usefulness, perceived ease of use, attitude towards use and external variables.

4. Analysis

This section highlights the characteristics of blockchain and goes on to discuss popular blockchain use cases on Twitter, followed by the benefits and drawbacks of blockchain.

4.1. Blockchain characteristics

This section presents the analysis for RQ1. In the extracted sample, 5918 unique tweets had been retweeted 80% times. The blockchain characteristics were mapped within 5,918 tweets using manual content analysis techniques. Content analysis (Kassarjian 1977) is a technique which converts qualitative data into quantitative data for statistical analysis. The reliability of the process is improved by allowing more than one judge to map the tweets to characteristics, such that consensus is achieved.

In manual content analysis, there were 136,114 decision points, i.e. for 5918 unique tweets were mapped to 23 characteristics. Two independent judges agreed on 119,685 decisions and disagreed on 16,429 decisions resulting in a higher coefficient of reliability, 87.93%. The literature suggests that 85% and above coefficients of reliability for the studies is sufficient (Kassarjian 1977). The choices of the categories enhance or diminish the likelihood of the valid inferences (Berelson, 1952). Therefore, a close check was done on the mapping by both the judges. The top characteristics of blockchain discussed on Twitter are presented in Figure 5.

The literature mapped these characteristics to potential benefits in strategic, organisational, economic, informational and technological categories (Ølnes, Ubacht, and Janssen 2017). Hypothesis H1 investigates the mean discussion regarding blockchain technology on Twitter.

H1: All potential benefits of blockchain (clustered under strategic, organisational, economic, informational and technological characteristics) are discussed equally on Twitter.

$$\mu_{strategic} = \mu_{\mathrm{organisational}} = \mu_{\mathrm{economic}} = \mu_{informational} = \mu_{technological}$$

Let α = 0.05 (assumption), the degree of freedom is (k-1, n-k), where k is the number of samples (k = 5; strategic, organisational, economic, informational and technological) and n is the total number of observation (n = 23; blockchain characteristics identify from literature). The degree of freedom for this is equal to (4, 18). The decision rule states, if the calculated value of F is greater than the table value of F, reject H1. The table value of F at 5% level of significance for degrees of freedom (4, 18) is 2.93. The F-statistic is the ratio of the variability between groups to the variability within groups.

The calculated value of the F-statistic for the blockchain discussions surrounding characteristics is 0.503 which is less than the threshold value of 2.93. Therefore, H1 is not rejected. Hence, there is no significant difference between means of discussions surrounding blockchain characteristics. This indicates Twitter had been used equally for discussions related to strategic, organisational, economic, informational and technological characteristics.

Figure 6 presents the flow of information regarding blockchain characteristics in the top 80% retweets with the following colour coding: purple – technological characteristics;

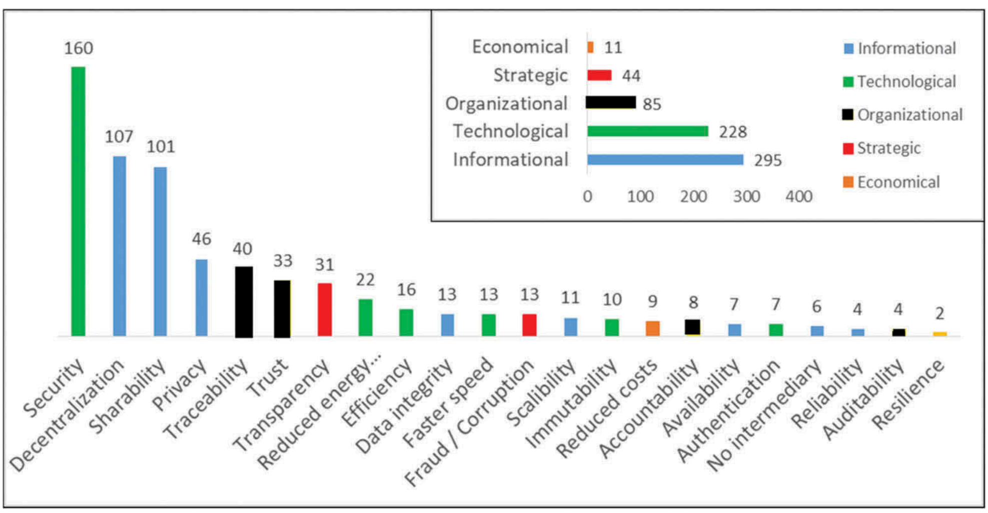

Figure 5. Blockchain characteristics arranged in descending order of popularity on Twitter.

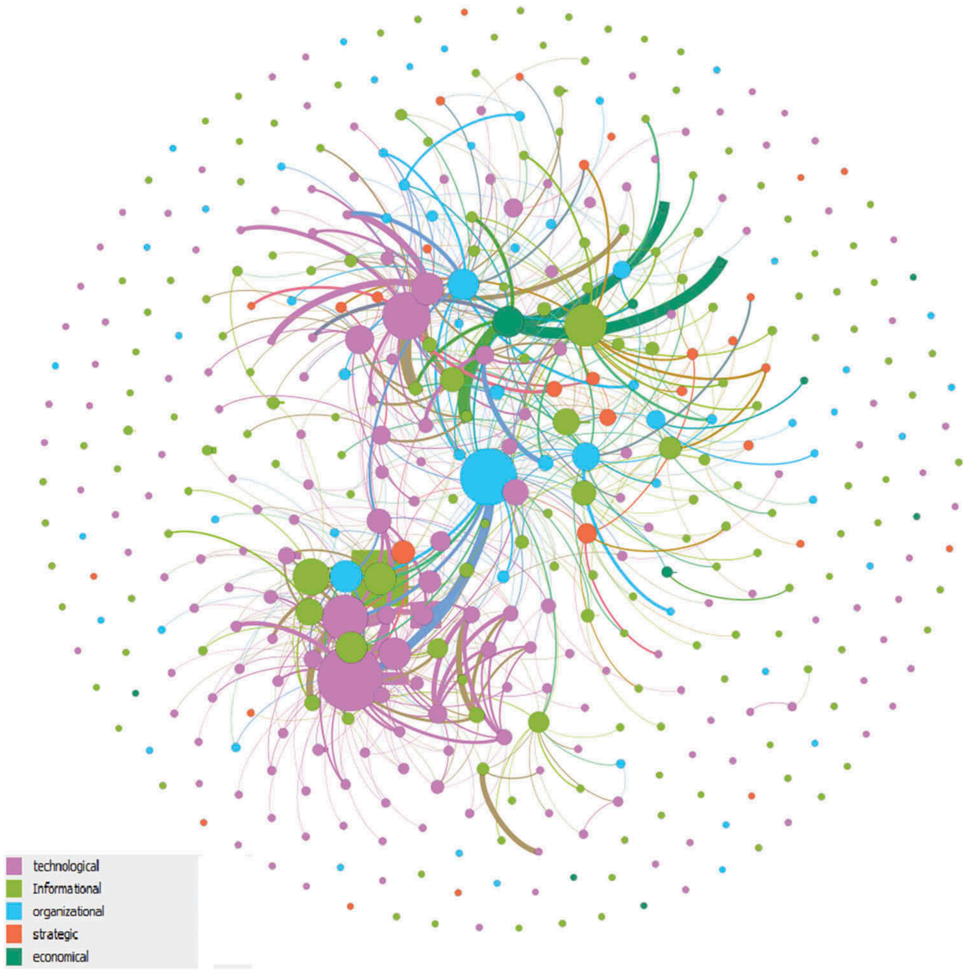

Figure 6. Communication among users regarding strategic, organisational, economical, informational and technological characteristics of the blockchain.

light green – informational characteristics; blue – organisational characteristics; red – strategic characteristics; and dark green – economic characteristics. Some of the network parameters (Shan, Ren, and Li 2017) are listed below: number of nodes – 449; number of edges – 676; average degree – 3.011; average weighted degree – 10.367; network diameter – 7; graph density – 0.007; connected components – 178; average clustering coefficient – 0.131; and average path length – 3.403. The graph shown in Figure 6 has a graph density equal to 0.007 and average clustering coefficient equal to 0.131 which indicates that the graph is weakly connected and the users are dispersed in the network. There are 178 connected components in a network of 449 users, which indicates on average 2 or 3 users in one connected component which indicates a loosely coupled network.

Figure 6, presents the flow of blockchain characteristics information within Twitter users. The node size indicates the tweeting frequency of the user with '#blockchain'. The larger the size of the node indicates the more the users had tweeted compared to others. For the technological and organisational characteristics, some users tweet more heavily whereas for the informational and strategic characteristics use is distributed more evenly across the users. The weights of the edges depict the frequency of communication between the users. Figure 6 shows that some users are frequently discussing the economic characteristics together. In terms of percentage, informational characteristics (44.49%) are discussed most among users, followed by technological (34.38%); organisational (12.82%); strategic (6.64%); and economic (1.66%) characteristics. The informational and technological characteristics were discussed and shared more compared to other characteristics.

4.2. Use cases

The popular use cases related to blockchain are ICO, smart contract and distributed ledger as shown in the literature (Table 2). From 341,309 tweets collected for the study, the top 100 hashtags were identified. From these, those related to blockchain use cases such as #cryptocurrency or #coin or #money; #smartcontracts; #data or #datascience or #dlt; were selected. Figure 7 shows the number of tweets in the sample associated with dominant use cases hashtags. The counts of the tweets for #coin, #money, #smartcontracts, #data, #datascience and #dlt were between 2 and 382 and for #cryptocurrency the count was between 133 and 1721.

To statistically validate significant differences in the distribution of discussion surrounding blockchain use cases on Twitter, we proposed hypothesis H2.

H2: The distribution of discussion on blockchain use cases (initial coin offering, smart contract, and distributed ledger) is similar on Twitter in the study time frame.

The distribution of the discussion on use case on a daily basis did not satisfy normality and homogeneity conditions, so we applied the non-parametric test Kruskal–Wallis H test. The test showed a statistically significant difference in discussions between different blockchain use cases discussions, $\chi^2(2) = 148.082$, $p < .001$, with a mean rank discussion of 147.45 for ICO, 32.71 for smart contracts and 86.84 for distributed ledgers.

The perceived ease of use for the application on blockchain was measured using users' sentiment analysis. The sentiment analysis (Liu 2010) of the use cases tweets

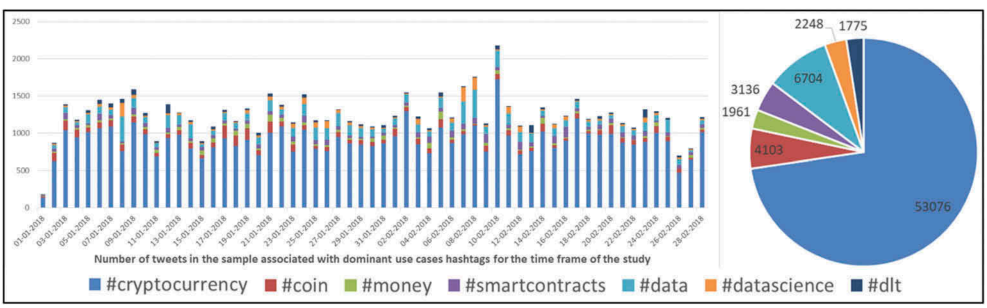

Figure 7. The number of tweets in the sample associated with dominant use cases hashtags for the time frame of the study on alternative days.

helped us to determine Twitter users' opinions regarding blockchain use cases. We computed the sentiment analysis of the tweets on the basis of the words' polarity in the tweets. A list of positive and negative words was taken from the literature (Hu and Liu, 2004; Liu, Hu, and Cheng 2005). On the basis of the number of positive and negative words in the tweet, the sentiment score was computed for each tweet. Figure 8 presents the sentiment analysis for blockchain use cases.

Besides #cryptocurrency or #coin or #money hashtags, ICO hashtags, #bitcoin or #btc, #xrp, #altcoin, #digibyte, #trx or #tron, #litecoin or #ltc, #edinarcoin and #dash also occurred in the top 100 hashtags. Bitcoin is the most popular currency among all coin offerings. Bitcoin tweets are the most liked and retweeted by users on Twitter. The use cases related to ICO are more frequently discussed compared to smart contracts and the distributed databases.

4.3. Benefits and drawbacks

The literature indicates that transaction cost, transaction time, security and trust are the perceived benefits (Cohen, Samuelson, and Katz 2017; Kogure et al. 2017; Kshetri, 2017; Shermin 2017) whereas power consumption and hardware cost are some of the challenges faced when implementing blockchain technology (Cocco, Pinna, and Marchesi 2017; Fairley 2017). According to the literature, the perceived risks in using blockchain technology include the disintermediation of intermediaries (Adams et al. 2017; Kshetri 2017) and multiple identities of users (Alabi 2017). We searched these benefits and drawbacks in the sample, using the lexicon-based method.

To identify the tweets related to transaction cost, we searched the lexicon 'cost' in the sample. Once identified, the semantics of the tweets were checked, whether the tweet was talking about transaction cost or some other cost. Once the tweet semantic was checked and found relevant, we considered the tweet for further analysis. The same process was repeated for other benefits and drawbacks. The lexicons used for other benefits and drawbacks are given in brackets as follows: transaction time (time), security (security), trust (trust), power consumption (power), hardware cost (hardware),

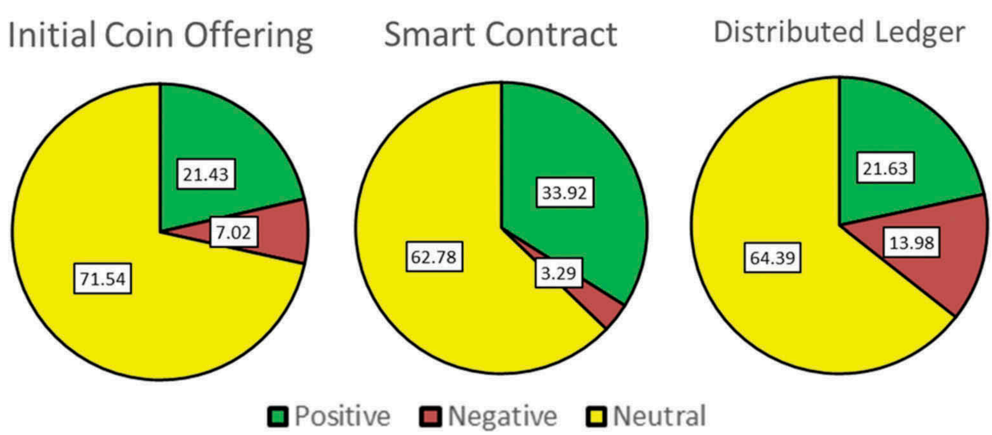

Figure 8. Sentiment analysis of use case tweets.

disintermediation of intermediaries (intermediary/intermediaries) and multiple identities of users (identity and identities).

Figure 9 shows the distribution of the discussion on benefits and drawbacks of the study across the time frame of the study. The sample counted the following benefits in decreasing order of popularity: security, transaction completion time, transaction cost and trust. The sample counted the following drawbacks in decreasing order of popularity: power consumption; users multiple identities; hardware cost and disintermediation.

Hypothesis H3 is an attempt to statistically validate the distribution of discussions on blockchain benefits and drawbacks.

H3: The distribution of discussions on blockchain benefits and drawbacks are similar on social media across the time frame of the study.

The mean benefits of discussions are 344.01 and for drawback-related discussions, it is 178.61. The benefits discussions distribution appeared to be significantly normal $D(59) = 0.066$, $p < .05$ but drawbacks discussions distribution was not normal $D(59) = 0.001$. The assumption of homogeneity is met, $F(1,116) = 0.175$. The distribution was not normal but homogeneous, so we applied a non-parametric test, the Mann Whitney test. The Twitter users were significantly discussing the benefits of blockchain more $U = 278$, $z = -7.872$, $p < .001$, than the drawbacks.

5. Discussion

This section presents the insights derived from the Twitter data for the three research questions. The literature sees blockchain as an upcoming disruptive technology in many sectors (Kogure et al. 2017), but there is no clear evidence for blockchain acceptance by the user. This paper uses technology acceptance constructs (Davis 1989; Davis, Bagozzi, and Warshaw 1989) for blockchain technology, as presented in Figure 3, along with four constructs: perceived usefulness, perceived ease of use, attitude to use and external variables.

RQ1: What are the primary characteristics of blockchain? How have these characteristics been discussed on Twitter?

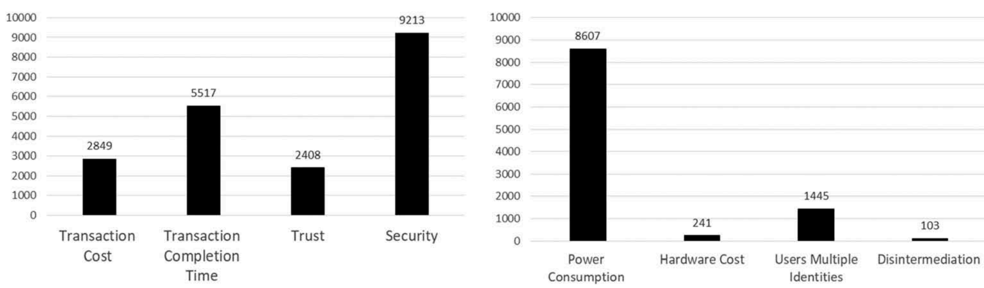

Figure 9. (a) Distribution of discussion surrounding blockchain benefits and; (b) Distribution of discussion surrounding blockchain drawbacks; across the time frame of the study.

The primary characteristics of the blockchain are shown in Table 1. The study shows that digital transactions on blockchain are beneficial regarding security, decentralisation, shareability, privacy, traceability, trust and transparency (the three Ts). Users demand the three Ts in their tweets for digital transactions along with speedy and secure (the two Ss) transactions over the internet with reduced overhead cost.

The analysis of Twitter discussions shows: (a) the security provided by blockchain with regard to digital transactions is in line with the literature (Cuccuru 2017; Kogure et al. 2017); (b) blockchain supports trustworthy digital transactions within decentralised networks and will transform the boundaries of the organisations in future; and (c) blockchain as a data storage medium enables the transparent traceability of goods across all stages of the supply chain; The discussions indicate that blockchain characteristics are disrupting the ways financial, banking, health and supply chain sector perform, since blockchain characteristics are extensively discussed on Twitter.

The literature indicates that blockchain benefits are not supported by empirical evidence (Ølnes, Ubacht, and Janssen 2017). The study statistically validated blockchain primary characteristics discussions on Twitter by mapping them into strategic, organisational, economic, informational and technological benefits (Ølnes, Ubacht, and Janssen 2017). We used the frequency occurrences of the characteristics in the tweets to statistically test H1, and our results indicate that Twitter is used for discussions related to strategic, organisational, economic, informational and technological characteristics in equal proportions. In numbers, informational characteristics of blockchain are the most discussed, followed by the technological, organisational, strategic and economic characteristics of blockchain, which is in line with literature (Ølnes, Ubacht, and Janssen 2017) and indicates that informational characteristics (data integrity and higher data quality) can lead to organisational characteristics (transparency).

Figure 6, shows the flow of information related to blockchain characteristics. The informational characteristics are more frequently discussed and shared compared to technological characteristics, but the influence of the technological characteristics is greater compared to the informational characteristics (Figure 6). This may be due to the higher need for cybersecurity (Shackelford 2016; Tehrani, Manap, and Taji 2013) for digital transactions which can be provided by the immutability of the records (Huckle and White 2016; Nordrum 2017; Lu and Xu 2017; Tai, Sun, and Guo 2016).

The Twitter analysis indicates that security, privacy, the three Ts, speed, reduced costs, authentication and removal of intermediaries are perceived as the usefulness of the blockchain for digital transactions. The security and the three Ts provided by blockchain can help the systems to reduce corruption, fraud and bureaucracy, which can subsequently improve the efficiency, performance, effectiveness and quality of digital transactions.

RQ2: What are the primary use cases of blockchain? How have these use cases been discussed on Twitter?

The primary use cases of blockchain shown in Table 2 are: ICO, smart contracts and distributed ledgers. The frequency of the hashtags related to blockchain use cases was mapped on a day-by-basis, but due to limited page width, it is presented on an alternative day basis (Figure 7) and these values are used to statistically validate H2.

The results of H2 indicate that there is a statistically significant difference in discussions of blockchain use cases.

ICO was extensively discussed on Twitter, followed by distributed ledgers and smart contracts. The sample indicates users also discussed other ICOs than Bitcoin using the hashtags #xrp, #altcoin, #digibyte, #trx or #tron, #litecoin or #ltc, #edinarcoin and #dash. The literature opines that Bitcoin has attracted a billion dollar economy (Tschorsch and Scheuermann 2016) which explains why Bitcoin tweets are the most liked and retweeted by users. The perceived ease of use of ICO, smart contract and distributed ledger was measured using sentiment analysis. For all the use cases, the neutral sentiment is greater than the positive and negative sentiments. This is obvious as blockchain is an upcoming technology, and its use cases are considerably new; therefore, actors are using Twitter for enquiries. If the neutral tweets are removed, then the majority of the tweets are positive tweets, inferring a positive outlook of users towards blockchain technology. Figure 8 shows that smart contracts have the highest percentage of positive tweets followed by similar percentages for distributed ledger and ICO. Literature indicates that easier systems are most likely to be adopted by the users (Davis 1989). The sentiment score approach as suggested in the literature (Ma and McGroarty 2017) enabled the researchers to evaluate users' perception, opinion and attitudes towards the new use cases of the technology. The findings suggest that the next upcoming application of blockchain appears to be smart contracts.

The analysis indicates that smart contract is seen positively by users, in line with the literature which indicates the urgency of smart contract deployment in the financial and banking sectors (Cuccuru 2017), medical data storage and sharing (Roehrs, Da Costa, and Da Rosa Righi 2017; Xia et al. 2017; Benchoufi, Porcher, and Ravaud 2017); and land regulations (Herian 2017; Zhang and Wen 2017). Instances of all these use cases were discussed on Twitter. The tweets indicate that smart contract (a) minimises uncertainty in transactions; (b) reduces monitoring expenses; and (c) is self-enforceable, triggering conditions that can open new business areas.

RQ3: What are the dominant benefits and drawbacks of blockchain technology? How have these benefits and drawbacks been discussed on Twitter?

Blockchain has many benefits for digital transactions: it reduces transaction cost and time, and subsequently increases security and trust in online transactions. However, to implement blockchain requires heavy infrastructure and high power consumption and involves the risks of multiple user identities and disintermediation of intermediaries. To statistically validate H3, whether users are discussing more about benefits or drawbacks, we tracked blockchain benefits and drawbacks on a daily basis. The results of H3, indicate that Twitter users discuss blockchain benefits significantly more often than they do the drawbacks. The most discussed benefit of blockchain is security with 9213 tweets followed by the transaction completion time with 5517 tweets. The most discussed drawback of blockchain is power consumption with 8607 tweets followed by the users multiple identities with 1445 tweets.

6 Conclusion

This study investigates the acceptance drivers of blockchain by extracting Twitter feeds to derive their collective intelligence. On the basis of the literature (Davis 1989; Davis, Bagozzi, and Warshaw 1989) the (a) the perceived usefulness of the blockchain was mapped to the characteristics of blockchain; (b) the perceived ease of use was mapped to use cases sentiment score among users on Twitter; (c) the attitude toward use was mapped to the benefits of the blockchain; and (d) the external variables were mapped to drawbacks of the blockchain.

The study indicates that blockchain is gathering attention because of the characteristics and benefits offered by the technology. The findings show that blockchain can transform digital transactions by: (a) reducing transaction overhead cost; (b) providing secure and speedy (2Ss) transactions; and (c) providing security, privacy, transparency, trust and traceability (3Ts) in the digital transactions. The literature indicates that in today's digital world, security is greatly needed (Shackelford 2016; Tehrani, Manap, and Taji 2013). Our analysis shows that users feel that blockchain may provide security to digital transactions. Whether this is so is beyond the scope of this present study and is something to be explored by future researchers. Twitter was used for analysing discussions related to strategic, organisational, economic, informational and technological benefits of blockchain technology. The informational characteristics were discussed on Twitter and these are shown to be shared more often compared to the technological characteristics; however, the influence of the technological characteristics is more frequent compared to the informational characteristics.

The study found that ICO was extensively discussed on Twitter as compared to other blockchain use cases, smart contract and distributed ledger. Bitcoin is the most popular among all ICOs. The findings show that discussions were more inclined towards blockchain benefits than to drawbacks. This may be seen as a signal that users are open to accepting blockchain technology for digital transactions but might also suggest that they are largely unaware of the drawbacks. The findings of this study confirm that 'blockchain will be as revolutionary as the Internet' (Dai and Vasarhelyi 2017) and 'blockchain will lead ICT for the next generation'. Subsection 6. shows the implications for practice along with guidelines for IT and general managers and researcher and academia for further development in blockchain, and Subsection 6.2 lists the limitations of the study, along with the future scope.

6.1. Implications for practice

The study proposes a new research approach of extracting collective intelligence of users from Twitter and subsequently using it to present the characteristics, use cases, benefits and drawbacks of the technology. The research approach used in the study is comprised of four stages: capture, analyse, visualise and comprehend for extracting insights from the social web (Twitter). Future researchers can use this research approach for mining the collective intelligence of the users for different purposes such as technology evolution, technology acceptance, trend analysing and many more. To the best of our knowledge, this study is the first to demonstrate a technology acceptance model for blockchain technology. The study also shows users within the virtual world discussing blockchain benefits (attitude towards use) occurred more often compared to drawbacks (external variable). This highlights the positive outlook of users towards blockchain and indicates a bright future for this technology, but might also indicate a limited understanding of the drawbacks. Blockchain applications can offer new commercialisation opportunities (White 2017). The study highlights blockchain use cases, such as ICO, that can provide faster transactions, disintermediate financial intermediaries, support cross border transactions and create an open economy. Smart contracts can provide trusted networks; self-enforceability; and control and easy access. Distributed databases can provide a sharing economy, immutability, high availability and the absence of single administrator. On the basis of the results of the study, the authors provide guidelines for using blockchain technology in Subsection 6.1.1 for IT managers and general manager and in Subsection 6.1.2 for researcher and academics.

6.1.1. Guidelines for IT and general managers

The study suggests the following guidelines for IT managers and general managers who are working in the domain of transferring value over the internet (digital transactions) and who are planning to use blockchain technology:

(a) The blockchain can provide two Ss and three Ts in transferring value through internet which can enhance efficiency, performance, effectiveness, quality and ease of digital transactions.
(b) Twitter has been used for discussions related to strategic, organisational, economic, informational and technological benefits. IT managers and general managers working in blockchain can use Twitter profiles for gathering news and updates related to these benefits and subsequently can use blockchain for the same.
(c) This analysis suggests that blockchain will lead ICT in the next generation, and manpower is needed at different levels of implementation of blockchain solutions such as designers, developers, operators, regulators and many more.
(d) The literature shows that for the most part, academics and the industry have built their own platforms for gaining collective intelligence. The study suggests extracting collective intelligence and crowd wisdom from the social web. This has two advantages over building a platform: firstly, the cost for building the platform will be saved; and secondly, it enables larger and more diverse group perspectives to be analysed.

6.1.2. Guidelines for researchers

The study suggests the following guidelines for researchers and academics for further development in blockchain and regulation of the application built on blockchain:

(a) Users are attracted towards the blockchain due to the promise of high levels of security and speedy transaction. Therefore, blockchain researchers should focus on realizing these characteristics.
(b) Users are concerned about power consumption of blockchain technology and having multiple user's identities. Therefore, the developers and researcher of blockchain technology should come up with the blockchain implementation

model where these concerns can be taken care of. Self-sovereign identities should be created.

(c) The use cases built on blockchain, ICO and smart contract technology has the potential of disrupting the way digital transactions used to take place in various industries. Therefore, academia should take steps in to promote and educate the public for understanding and adopting these use cases (Gomber et al. 2018).

(d) *On the basis of the result of the study, it can be concluded users are open to accept blockchain for digital transactions. Therefore, there is a need for policy-makers supported by researchers and academics to elicit the regulations needed for these applications and to highlight the surrounding norms and ethics.*

6.2. Limitations and future research

The study has some limitations. Firstly, sentiment analysis on the basis of the number of positive and negative words in the tweet was used to calculate the sentiment score to each tweet. A positive sentiment score indicated a positive tweet, a negative sentiment score indicated a negative tweet and a zero sentiment score indicated a neutral tweet. This way of computing the sentiment score is not always very accurate as it focuses on individual words and does not consider the semantic of the tweet. A second limitation is that there was no mechanism in the study for differentiating between ad-like tweets and non-ad-like tweets. The Twitter Search API was used for tweet extraction.

In future research, the blockchain acceptance model could be empirically validated. More research is needed to understand the perceived usefulness and perceived ease of use for blockchain technology over other technologies. This study is the first and initial step in this direction. Researchers could focus on each feature of the blockchain and examine how blockchain can open new opportunities for businesses and organisations. The study could be also used as evidence of extracting wisdom from the collective intelligence of Twitter users in the context of technology acceptance.

Disclosure statement

No potential conflict of interest was reported by the authors.

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