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Measuring the perceived benefits of implementing blockchain technology in the banking sector

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ABSTRACT

This study aims to measure the perceived business benefits of blockchain technology implementation in the banking sector and establish factors to measure these benefits. Concerns regarding security, values, and standards are essential to banking operations. Data was collected from 291 respondents who are either blockchain consultants, blockchain marketing experts, or CEOs/business heads of banks that are in the process of advising, consulting, or implementing blockchain technology. Confirmatory factor analysis (CFA) was carried out to assess the reliability and validity of the proposed instrument. The results support the proposed instrument and its five constructs. The scale emerging from this study indicates a good degree of reliability, validity and unidimensionality in each of its constructs. Technologies like blockchain are in their initial stages, and recent advances in blockchain technology may impact our findings. The developed instrument could help give decision makers a foundational view to measure the benefits of implementing blockchain technology before they choose to integrate it in their existing system. The scientific and societal significance of the study based on its practical and theoretical applications is presented at the end.

1. Introduction

In recent years, our society has experienced the emergence of an innovative wave of disruptive technologies spread among different industries labelled "Industry 4.0″ (Hou et al., 2020; Chang et al., 2019). In the early years, the concept of Industry 4.0 was confined to the manufacturing sector (Skilton and Hovsepian, 2017). By using Industry 4.0 disruptive technologies, many manufacturing units have witnessed an enhancement in their capabilities and performance (Büchi et al., 2020; Szalavetz, 2019). In addition to manufacturing companies, many service industries ranging from telecoms to banking are expecting benefits from the digital technologies of Industry 4.0 (Kohtamäki et al., 2020; Frank et al., 2019). These digital technologies have enabled many new business models (Sung, 2018). In today's world, the service industry accounts for the largest share of GDP in most advanced economies (Mariani and Borghi, 2019). These service industries are currently either using or testing these technologies to change the way they do business. A wide array of technologies such as cloud computing, 3D printing, the internet of things (IoT), and cyber physical systems (CPS) along with artificial intelligence (AI) and blockchain fall under the scope of the Industry 4.0 revolution (Chang et al., 2020c). The advantage of these disruptive technologies lies in their self-learning ability, their security and their predictive ability in dynamic conditions. Cloud computing can help integrate the knowledge and needs of customers with data for personalized services in the banking industry (Larson and Chang, 2016; Zineldin and Vasicheva, 2015). In financial services, security is always a concern, and the IoT has therefore been applied to payments, banking and insurance activities (Mani and Chouk, 2018). Apart from this, CPS has enabled real-time service abilities like automatic teller machines (ATM) and mobile financial services (Gai et al., 2017). Machine learning, which is one of the AI technologies, helps banks serve customers faster and comply with regulations. In addition,

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these technologies are utilized for supervisory purposes (Wall, 2018; Moro et al., 2015).

Banks and financial institutions are considered to be the lifeline of modern society and act as a catalyst in stimulating and nourishing economic growth in developing countries like India (Iqbal and Sami, 2017; Disyatat, 2004). The Indian banking sector is facing issues such as increasing operational costs, an ever increasing number of fraudulent transactions and challenges in ensuring transparency (Kumar and Prakash, 2018; Jayadev et al., 2017). The banking system needs to explore robust technologies to avoid fraud and carry out transactions quickly (Sunder et al., 2019; Repousis et al., 2019). Furthermore, the system needs to ensure cost efficiency in its operations and transparency for its customers and regulators (Altankhuyag, 2019; Ray, 2016; Dong et al., 2014). To this end, the banking sector has adopted many platforms that are driven by technologies to enhance banking activity performance (Palmié et al., 2020). Blockchain has the potential to eliminate intermediaries, improving transparency and traceability of transactions by streamlining, simplifying and enhancing the traditional business processes of banks (Frizzo-Barker et al., 2019; Hassani et al., 2018; Hyvärinen et al., 2017). According to Accenture, the global banking sector can save up to $20 billion by the year 2022 via the innovative application of blockchain (Accenture, 2018).

Blockchain technologies are considered promising, innovative, and have a substantial influence on industry and social order (Alter, 2019; Wu et al., 2019; Chen, 2018; Ducas and Wilner, 2017). Blockchain in banking and investment-related solutions weathered a period of cynicism before its significant worth was recognized (Pereira et al., 2019; Gartner, 2018). Blockchain technologies are the foundation of many cryptocurrencies such as bitcoin (Wang et al., 2019c; Li et al., 2017). It is a distributed ledger technology that can register transactions among two or more parties (Iansiti and Lakhani, 2017; Kuo et al., 2017; Lemieux, 2016). According to reports by Gartner, "*Blockchain is an expanding list of cryptographically signed, irrevocable transactional records shared by all participants in a network. Each record contains a time stamp and reference links to previous transactions*". Based on this information, participants with the right permissions and access can track the transaction history (Andoni et al., 2019; Drosatos and Kaldoudi, 2019; Beck et al., 2017). Blockchain can be further classified into public and private chains. In the public blockchain network, there is no limit set by management, and anyone can join the chain (Viriyasitavat and Hoonsopon, 2019; Ying et al., 2018; Marsal-Llacuna, 2018; Sikorski et al., 2017). It can be maintained by anyone with enough computational power. The public model allows for self-certification of participants to join or quit at will and has decentralized trust with no central identity management (Cangemi and Brennan, 2019; Saberi et al., 2019; Alabi, 2017). Private blockchain networks are closed groups that support models with centralized identity and membership requirements, making overall control much easier, but limiting participation (Morkunas et al., 2019; Vranken, 2017; Yoo, 2017). However, secure and efficient private blockchain could be vulnerable to manipulation due to centralized governance (Shrestha et al., 2019; Reyna et al., 2018; Kshetri, 2017). In addition, the benefits of blockchain can be viewed through the lens of institutional, market, and technical factors (Governatori et al., 2018; Koppenjan and Groenewegen, 2005). The narrative of blockchain's scientific aspects has been examined from a theoretical perspective as compared to a technical or architectural one (Liu et al., 2019; Lemieux, 2016). Hardly any effort has been made in the literature regarding the development of an instrument to measure the perceived paybacks of executing blockchain technology with a specific focus on the banking sector. The background of blockchain technology therefore leads us to pose the following research questions:

R1. *What are the perceived business benefits of implementing blockchain technology in the banking sector?*
R2. *How can we measure the perceived benefits of implementing blockchain technology in the banking sector?*

In this paper, first we discuss the theoretical background based on prior research to measure the perceived benefits of implementing blockchain technology with a specific focus on the banking sector. Second, we discuss the findings of the qualitative investigation with which we developed an initial pool of instrument items to measure the perceived benefits of implementing blockchain technology. Third, we present the outcomes of our study with sample data collected from blockchain consultants, blockchain marketing experts and CEOs/business heads of banks that serve to purify and validate the instrument. We then elaborate on our findings in the discussion section. After the discussion section, we present the theoretical and practical implications. Finally, we conclude the study and present the limitations and future scope of research.

2. Literature review

2.1. Blockchain technology use in the banking sector

The Indian banking industry is currently experimenting with and examining a number of business circumstances and their relationship with blockchain technology, such as vendor financing, customer loyalty programs, and syndicated loans (Deloitte, 2017). Popular banks in India (for example: the Reserve Bank of India (RBI), Yes Bank, Axis Bank and the State Bank of India (SBI)) are considering the implementation of blockchain technology, which may be much faster, more transparent, and more secure way to serve their customers more efficiently (Andoni et al., 2019; Sharma, 2018; Yoo, 2017). The State Bank of India is the largest bank and has been the first to develop a blockchain consortium for financial transactions composed of about 10 banks. The bank completed its first project using blockchain to enable its members to share Know Your Customer (KYC), Combating the Financing of Terrorism (CFT), and Anti-Money Laundering (AML) situations (Gupta, 2018). However, this technology has yet to be verified with regard to know-how (Zheng et al., 2018; Nofer et al., 2017). Apart from India, other countries and firms are using different approaches to blockchain. Well-known econometric models have been adapted and applied to improve analysis and make businesses more competitive (Ji et al., 2020). Blockchain as a technology has the potential to be exceptionally useful to the investment and banking industry as an eco-system (Hassani et al., 2018; Beck, 2017; Oh and Shong, 2017). Literature on the benefits of implementing blockchain in the banking sector are available from various sources, such as industry published whitepapers, blogs, wikis, and conference proceedings (Cole et al., 2019; Hyvärinen et al., 2017; Larios-Hernández, 2017; Yeoh, 2017). This section discusses the prospective benefits of implementing blockchain technology from corner to corner in the banking sector.

Banks primarily apply blockchain technology for fund transfers, registrations, and maintaining back-end utilities (Andoni et al., 2019; Taylor et al., 2019; Zheng et al., 2018). This technology works like a distributed ledger and is completely open to anyone and everyone in the network. Once the data is registered in blockchain, it is very difficult to alter or transform it, making blockchain inherently secure (Pratap, 2018; Reyna et al., 2018; Iansiti and Lakhani, 2017). Jaag & Bach (2017) studied the opportunities that may arise from blockchain technology in postal organizations, such as decentralized platforms, secured record-keeping and fast transaction systems. This sector, like the banking sector, is starting to explore blockchain to improve its operations. Different banks have different approaches to experimenting with and adopting this technology. Some banks are exploring internal options first, while others are trying to use the technology to explore options between banks first (Andoni et al., 2019; Rijmenam, 2018; Eyal, 2017).

Blockchain technology is a cross-boundary process providing trusted and efficient solutions to multiple stakeholders in multiple organizations (Dubey et al., 2020; Upadhyay, 2020; Manski, 2017). It provides a platform for innovation to meet the needs of stakeholders based on their expectations and applications. (Chen, 2018; De la Rosa et al., 2017).

This technology is an accurate representation of data structure that keeps track of multiple transactions and safeguards the transparency, security, and decentralization of the data (Andoni et al., 2019; Knirsch et al., 2019; Zhang et al., 2018). Blockchain technology is expected to bring greater transparency to monetary transactions and advance the efficacy of countries' financial systems (Kshetri, 2017; Guo and Liang, 2016). Blockchain technology can provide a new revolution especially in the banking sector with better payment clearing mechanisms and upgraded credit information and management systems, which would lead to a more efficient banking system (Cai et al., 2019; Mengelkamp et al., 2018; Guo and Liang, 2016). The remittance cost through blockchain accounts to 2 to 3% compared to 5 to 20% through third-party facilitation in the traditional banking system, especially in cross-country payments. However, if the payments are made in cryptocurrencies, this may pose certain challenges. Therefore, until a balance of interests and regulations is achieved among countries, payments using cryptocurrencies may not be possible (Zhang et al., 2020). Apart from this, blockchain provides a new institutional technology as it influences the transaction cost in a new decentralized system and redefines the governance of banking companies (Nofer et al., 2017; MacDonald et al., 2016). Rahman et al. (2018) discussed the potential of blockchain in providing safe and secure networks for the financial system. Cai (2018) mentioned that blockchain technology eliminates financial intermediaries, as it provides direct peer-to-peer payments online and provides digital contracts without government regulatory control.

The most frequently mentioned benefits of blockchain technology include cost efficiency, above-average profits, better recordkeeping systems, smart digital contracts with universal online identification systems, a safe digital platform, scope for improvement and few regulatory controls (Andoni et al., 2019; Puthal et al., 2018). Some of the paybacks of industrial blockchain include enhanced compliance, reduced risk, advancement and streamlining of capabilities, and reinforcement and automation of trust, which are age-old business processes (IBM, 2016). In addition to this, the underlying technology optimizes clearing process efficiency and financial asset spending following transactions and leads to a reduction in costs (Hassani et al., 2018; Tapscott and Tapscott, 2017; Guo and Liang, 2016). According to Nelito (2018), the adoption of blockchain could potentially save billions of US dollars for the banking sector by radically decreasing handling and processing costs. Since each transaction block in blockchain has a timestamp, it can help reduce fraud in the banking industry (Oza, 2018; Harigunani, 2017). In the traditional system, it takes days to update ledgers, whereas blockchain technology can do it immediately, automatically, and transparently (Kim and Laskowski, 2018; Nofer et al., 2017). High data quality can be maintained in the banking system (Martin, 2018). Banks can reduce their transaction fees if they are able to reduce the costs of operations and eliminate intermediaries. Blockchain eliminates the risk of errors and duplication, and as a result, stored data is complete, accurate, and reliable (Reyna et al., 2018; Thurner, 2018; New Age Banking Summit Europe, 2018). Blockchain technology offers many opportunities, such as better financial infrastructure and sustainably-developed, efficient systems, especially in the banking sector (Lu et al., 2019). It promotes better economic growth and develops green technology all over the globe due to its low energy consumption. (Kouzinopoulos et al., 2018; Cocco et al., 2017). Dale (2018) argued that rapid international payments would condense expenses for banks immensely and result in a considerable improvement in terms of proficiency and competence. Blockchain can also lead to greater trust among occupational partners since access to technology is shared and they can depend on reliable records and robust safety structures (Iskandar, 2017). Blockchain is real-time and open-source to create value for the stakeholders in the banking system (Accenture, 2018). Radical changes in the existing banking system can foster innovation and lead to growth with a considerable decrease in risk through blockchain technology (Umalkar, 2016). It is easy to trace the identity of each authorized person in the blockchain-lead banking system, which helps to conduct reliable and accurate audits. Since the banking system is a part of the service economy, intangibility and simultaneity are essential characteristics. Service delivery, confidentiality, continuous innovation and integrity of data are therefore crucial in banking systems and can be implemented through technology like blockchain (Sivarajah et al., 2017; Iyer, 2016; Abdullah et al., 2011; Bygstad and Aanby, 2010).

Song et al. (2016) explained that blockchain empowers a databank that can be shared directly without a principal owner. They also identified some of the advantages, such as extraordinary quality of data, durability and reliability of data, empowered users, longevity, process truthfulness, transparency and immutability, a simplified ecosystem, increased transaction speed and significantly reduced transaction costs. In short, blockchain will push the system to become more resilient by helping banks authenticate, merge, and trade economic statements, validate agreements, retain reviews and audit tracks and discourage money laundering (Helo and Hao, 2019; Swaniti initiative, 2018; Kewell et al., 2017; Kshetri, 2017) According to Kloppmann (2017), blockchain for financial services means trust for all.

Blockchain can disrupt the banking industry by facilitating lower fees on fund transfers and bringing faster settlement systems through the distributed ledger, which can further reduce the cost of operations (Frizzo-Barker et al., 2020; Governatori et al., 2018). The society we live in often faces the need to raise funds due to unexpected events like disasters or pandemics, most recently with Covid-19. Blockchain could potentially offer a new model of access to capital as compared to traditional fund-raising systems (Chen, 2018). In today's society, most people need loans for their present and future requirements such as housing, vehicles, and other personal needs. Blockchain can help eliminate the gatekeepers in the process of getting a loan with a lower interest rate and offer a rate more quickly (Wang et al., 2019d). Blockchain is therefore expected to change the way individuals and societies interact. Blockchain can help promote transparency, decrease costs and increase productivity, which will facilitate the social impact. We will describe the trends, challenges, and opportunities of blockchain with regard to the financial services sector below.

2.2. Trends in blockchain technology application

In recent years, blockchain-based applications have become increasingly common in the field of financial services (Casino et al., 2019; Zheng et al., 2017). Financial services and insurance firms are investing in blockchain technology to improve the security of certain data classes, enhance the capability of the system and increase cooperation with other setups (Pazaitis et al., 2017). Blockchain has been applied to financial asset management and economic transactions (Haferkorn and Diaz, 2015). Transactions are decentralized and immutable due to systematic ledger distribution. Blockchain is thought to contribute to global sustainable development by offering consumers the benefits of the current banking system (Liu et al., 2020; Nguyen, 2016). Blockchain has the potential to resolve the problems of trust, security, and control over data in financial services (Zhu et al., 2019; Iyer (2016)), and this is therefore another reason why financial services look to blockchain in the adoption of smart contracts (Wang et al., 2019a; Macrinici et al., 2018). It proposes a revolution in capital markets and makes operations more secure, especially through digital payment (Gao et al., 2018; Rohr and Wright, 2018; Yamada et al., 2017). Furthermore, activities including loan management, governance, general services, and auditing in financial services are more effective with the help of blockchain technology (Gazali et al., 2018; Dai and Vasarhelyi, 2017; Ølnes et al., 2017). Financial service organizations are taking steps towards this. For instance, JP Morgan Chase's Quorum unit is working on a blockchain solution with a special focus on contracts and the distributed ledger. Another firm, Bank of America, recently filed a patent and trademark for blockchain technology (Crosby et al., 2016). Another promising project is being spearheaded by Goldman Sachs to address the problem of volatility (Bouri et al., 2017). The adoption of blockchain-like technologies will help firms improve costs, customer care, and innovation capabilities. Stakeholders will soon develop more trust and accept blockchain as a sustainable part of their financial activities.

2.3. Challenges of blockchain technology application

Different industries and platforms have experienced problems in adopting blockchain. For instance, in e-governance, issues related to security, scalability, and flexibility are common (Chang et al., 2020a). In addition, a lack of legitimate and regulatory support is another barrier for blockchain in the public sector (Batubara et al., 2018). We have classified the challenges of blockchain technology applications into four categories:

2.3.1. Scalability

The scalability of processing power is another challenge with regard to the computational capability of devices, and that capability is addressed with limitations such as “sharding”. Sharding is an approach to splitting computational and workload storage into parts (Reyna et al., 2018; Sharma and Park, 2018). On the technical side, the available algorithms for different blockchains are currently slow and consume more energy than expected (Janssen et al., 2020; Upadhyay, 2020). In the energy sector, the way in which blockchain could facilitate peer-to-peer energy trading, electric vehicle charging, and e-mobility is still a question (Andoni et al., 2019). Many industries have invested heavily in their legacy systems, which work smoothly otherwise, making integration with these systems another challenge for blockchain (Schuetz and Venkatesh, 2020; Reyna et al., 2018).

2.3.2. Security

Blockchain technology is expected to top the market in the near future with its clear revenue potential, but blockchain security remains a concern due to the nature of distributed ledger technology (DLT). The critical vulnerabilities with DLT culminate outside the blockchain, at what is called an endpoint, where individuals and businesses access blockchain-based platforms (Lu, 2019; Gordon and Catalini, 2018). Public and private keys are required to access data and the possession of keys and ownership of content run parallel. Therefore, there is a strong chance that hackers could steal the keys to attack the system at its weakest point (Zhang et al., 2020). Due to weak security systems (flawed code) at their end, vendors risk having other partners expose blockchain credentials (Hughes et al., 2019). In many blockchains including bitcoin, an attack from a decentralized autonomous organization (DAO) could result from untested code.

2.3.3. Regulation and governance

While many organizations are counting on blockchain for many of their problems, they also face certain challenges. One roadblock is the lack of awareness and understanding of the technology among organizations (Saberi et al., 2019). Firms are also struggling to identify adequate platforms, suppliers, and partners to develop blockchain prototypes (Clohessy and Acton, 2019; Hughes et al., 2019). Customer data encryption is another major challenge due to the enhanced knowledge of hacking. There are no instructions and guidelines as to how financial services can utilize different modes of blockchain to manage their internal network and external exchange of information in terms of payments and transactions (Casino et al., 2019; Reyna et al., 2018). Though the decentralized approach of blockchain technology is a core characteristic, it poses definite restrictions on financial services (Karamchandani et al., 2020; Khan and Salah, 2018). Misalignment of objectives and motives among multiple stakeholders becomes a challenge in a decentralized environment (McCallig et al., 2019).

2.3.4. Cost and efficiency

The cost and efficiency of blockchain are critical concerns for many organizations (Casino et al., 2019; Zheng et al., 2017). Although, blockchain technology is fairly capable when it comes to reducing costs, it still faces limitations in legacy systems. The initial investment and infrastructure development for blockchain is expensive (Reyna et al., 2018). Smaller financial services or banks may prefer not to invest in this technology (Marco and Lakhani, 2017). High maintenance costs also create an obstacle to the adoption of blockchain technology (Cao et al., 2019). In fact, several obstacles must be overcome before this technology can be used. Blockchain adoption has complex human-related issues as well, such as knowledge-hiding, which was reported in the early days of adoption to prevent institutions or management from being successful (Chang et al., 2020b). Firms must therefore keep a close eye on blockchain development and prepare themselves for its adoption.

2.4. Blockchain technology application opportunities

Organizations need to encourage their employees to participate and attend internal knowledge sessions along with conferences on blockchain to enhance their capabilities (Lizcano et al., 2020; Attaran and Gunasekaran, 2019). Firms need to encourage cross-functional teams to develop a detailed plan for successful implementation of blockchain in their operations (Islam et al., 2019; Pazaitis et al., 2017). An alternate strategy needs to be built to mask data so that no one can access it (Wang et al., 2019b). In this virtual environment, regulators have an opportunity to analyze, contextualize, and control digital platforms. Blockchain offers a transformation in peer-to-peer payment along with current practices of storing and processing customer requirements. Blockchain can help insurance companies process claims by creating smart contracts (Wang et al., 2019a; Macrinici et al., 2018; Sharma and Park, 2018). This technology offers transparency and a complete traceability mechanism for every claim. The trade lifecycle includes multiple stakeholders ranging from settlement agents, custodians and brokerage firms to intermediaries (Montecchi et al., 2019). This system uses a traditional recordkeeping approach and allows room for inefficiency and error. Blockchain technology can therefore help automate the trade lifecycle by providing all parties with access to accurate data (Narayanaswami et al., 2019). Similarly, trade finance and the digital supply chain offer exciting opportunities for blockchain technology. This technology can help eliminate unnecessary documents like “letters of credit”, reduce costs by removing intermediaries, and develop a trusted network for stakeholders (Guo and Liang, 2016). Financial institutions across the world are required to comply with local regulators. One of the key requirements is “know your customer”, which can be time consuming without automated customer identification (Doughty, 2005). Blockchain can act as a single platform for customer identification and therefore allow an unlimited exchange of documents among financial institutions (Ying et al., 2018). This approach will help maintain privacy, which is a legal requirement. The consolidated list of the most frequently cited benefits of implementing blockchain in the banking sector is presented in Table 1.

2.5. Synthesis based on a review of the literature

Based on the literature and framework of Koppenjan & Groenewegen (2005), we have divided the perceived benefits of blockchain technology into institutional, market, and technical indicators in Table 1. Institutional indicators describe benefits based on the principles of rules and regulations among different stakeholders where benefits are derived from governance, cultural and regulatory domains. Blockchain can help develop a culture of minimizing fraudulent transactions and increase trust. Records become auditable by including the appropriate origin of different accounts and documents. Blockchain helps develop a strong governance platform. Blockchain offers numerous market-based benefits described under performance and business processes. Cost

Table 1
Consolidated list of benefits of implementing blockchain in financial services.

Indicators	Perceived benefits	References
Institutional Indicators		
Cultural	Increased trust	New Age Banking Summit Europe (2018), Tecsynt Solutions (2018), Harigunani (2017), Kloppmann (2017), Universal payments (2017), Krause et al. (2016)
	Reduced fraud & fraudulent transactions	Goyal (2018), Nelito (2018), Oza (2018), Tecsynt Solutions (2018), Unocoin (2018), Iyer (2016)
Regulatory	Improvement in regulatory compliance	Banks Editorial Team (2018), Goyal (2018)
	Increased auditability	Rijmenam (2018), Swanitiinitiative (2018), Trade finance (2018), Business Insider Intelligence (2017), Iyer (2016), Umalkar et al. (2016)
Governance	Ensure immutable business rules	Rijmenam (2018), Kloppmann (2017), Song et al. (2016)
	Improved tractability	Trade finance (2018), Umalkar et al. (2016)
	Immutable data record	Research report (2018)
Market Indicators		
Performance	Lower financial cost	Matteson (2017), Consultancy.uk (2016)
	Decreased transaction cost	Business Insider Intelligence (2017)
	Lower operational cost	Accenture (2018), Banks Editorial Team (2018), Centaure (2018), Dale (2018), Gupta (2018), Martin (2018), Nelito (2018), New Age Banking Summit Europe (2018), Oza (2018), Harigunani (2017), Iskandar (2017), IBM (2016), Krause et al. (2016), Song et al. (2016)
	Reduced processing cost	Nelito (2018), Consultancy.uk (2016)
	Reduction in administrative cost	Business Insider intelligence (2017), Matteson (2017), Consultancy.uk (2016)
	Risk reduction	Krause et al. (2016), IBM (2016)
	Increase in efficiency	New Age Banking Summit Europe (2018), Gupta (2018), Rijmenam (2018), Trade finance (2018), Tecsynt Solutions (2018), Harigunani (2017), Krause et al. (2016)
	Improved financial-market efficiency	Unocoin (2018)
Business process	Streamlining the business process	Business Insider Intelligence (2017), Kloppmann (2017)
	Real time information	Business Insider Intelligence (2019), Accenture (2018), Nelito (2018), Rijmenam (2018), Harigunani (2017), Iyer (2016)
	Eliminate intermediaries	Goyal (2018), Gupta (2018)
Technical Indicators		
Data quality	Data protection	Research report (2018)
	Data accuracy	Martin (2018), New Age Banking Summit Europe (2018), Tecsynt Solutions (2018), Harigunani (2017), Consultancy.uk (2016), Iyer (2016), Song et al. (2016), Umalkar et al. (2016)
	Control over data	Centaure (2018), Business Insider Intelligence (2017), Iyer (2016)
Distributed ledger characteristics	Increased security	Centaure (2018), Martin (2018), New Age Banking Summit Europe (2018), Nelito (2018), Research report (2018), Trade finance (2018), Iskandar (2017), Universal payments (2017), Umalkar et al. (2016), Iyer (2016), Krause et al. (2016)
	Better record keeping system	Koeppl & Kronick (2017)
	Reduce human intervention	Harigunani (2017)
	Faster settlement	Centaure (2018), Dale (2018), Martin (2018), New Age Banking Summit Europe (2018), Rijmenam (2018), Tecsynt Solutions (2018), Matteson (2017) Consultancy.uk (2016)
Infrastructure	System resilience	Nelito (2018), Swanitiinitiative (2018)
	Robustness	Nelito (2018)
	Automation	Goyal (2018), Tecsynt Solutions (2018), Business Insider Intelligence (2017), Universal payments (2017), Krause et al. (2016)
	Green technology	Cocco et al. (2017)
Information exchange & transactions	Increased speed of transaction	Krause et al. (2018), New Age Banking Summit Europe (2018), Harigunani (2017), Song et al. (2016)
	Eliminate the time delay	Oza (2018), IBM (2016)
	Ensure integrity of the system	Swanitiinitiative (2018), Harigunani (2017), Iyer (2016), Song et al. (2016), Umalkar et al. (2016)
	Reduced error in handling and reconciliation	Nelito (2018), Rijmenam (2018), Tecsynt Solutions (2018), Universal payments (2017), Business Insider Intelligence (2017), Matteson (2017), Consultancy.uk (2016)
	Increased speed of transaction	Krause et al. (2018), New Age Banking Summit Europe (2018), Harigunani (2017), Song et al. (2016)

reduction and minimization is one of the key parameters in enhancing the performance of financial services (Karamchandani et al., 2020). Different costs ranging from transaction, processing, and administrative costs must be examined to enhance financial-market efficiency and reduce risk among operations. Business processes also improve with real-time information, eliminating intermediaries and aligning processes. With regard to technical indicators, blockchain offers solutions to help drive perceived benefits. First, it facilitates data quality by providing adequate protection, accuracy, and control. Second, it offers enhanced security and an automated recordkeeping system along with faster disbursement and settlement. In any system, the architecture needs to be robust and resistant to disruptions. Therefore, the infrastructure of a financial system can define the sustainability of operations. Blockchain offers the characteristics of resilience, robustness and green technology (Kouzinopoulos et al., 2018). Apart from this, information exchange and transactions can be viewed as sources of perceived benefits in terms of speedy transactions, integrated systems, minimum error, and faster reconciliation. With the help of the above characteristics, we identified the areas of banking where blockchain can help transform the industry. Fig. 1 presents various application areas, from the cost of undertaking different activities to consumer service and trade finance, and illustrates how they securely connect with different parts of the value chain.

The banking industry heavily employs third parties to monitor and manage large transactions (Guo and Liang, 2016). The banking industry is burdened with the process of authenticating information and checking compliance at regular intervals. Blockchain can change this by eliminating the overlap in know-your-consumer and anti-money laundering

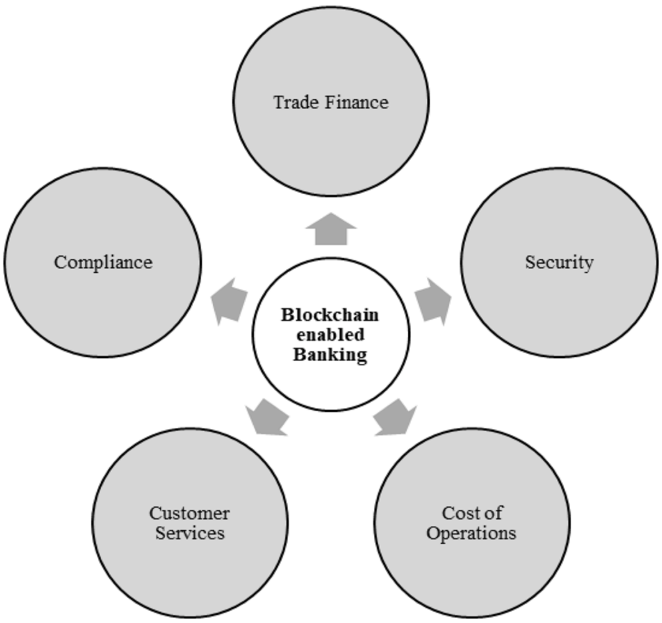

Fig. 1. Application areas of blockchain for the banking industry.

(AML) actions. For AML, blockchain can leverage artificial intelligence (AI) and machine learning (ML) functionalities to prevent and detect unlawful transactions. Blockchain-based AI and ML can effectively sift through data strings to identify signals of any illegal activity. These tools can help blockchain monitor transactions more efficiently and if any suspicious transactions are observed, they can be halted pending further investigation. Traditional banking systems have been seen to follow decades-old processes for approving transactions and lack transaction processing speed. Bank exchange charges are also high for certain transactions (Peters and Panayi, 2016). Funds exchanges and speed constitute increasingly important criteria for quality consumer services in the banking industry. Furthermore, economic activities can be accelerated by integrating trade finance and blockchain technology, where security and quick settlements are key.

3. Study design

This study aims to develop and validate a comprehensive instrument to measure the perceived business benefits of implementing blockchain technology in the banking industry. The research and development of a new instrument should include a comprehensive review of the existing literature followed by qualitative interviews to facilitate the identification of all relevant domains (Zomorodi and Lynn, 2010). According to Domegan and Fleming (2007), "*qualitative research aims to explore and discover issues about the problem in hand, because very little is known about the problem*". A review of the literature and the examination of a list of research papers published on blockchain technology have provided the foundation of knowledge and key insights of previous research focusing on the perceived benefits of implementing blockchain technology. A set of 35 items were initially identified from the existing literature (Table 1). They were then itemized into institutional, market, and technical indicators. It was assumed that these items would be most appropriate for measuring the benefits of implementing blockchain technology in the banking and related service industries. Since no instruments or conceptual models exist to describe the benefits of implementing blockchain technology in the banking sector, there was a limitation on generating an item pool for the instrument solely from the literature review. We therefore supplemented the literature review with qualitative research as a preliminary step in developing items to recognize the business benefits of adopting blockchain technology in the banking sector of the service industry. Fig. 2 presents the four-step methodology adopted in the study.

3.1. Preliminary study

During the summer of 2017, as part of a preliminary study, we identified thirty experts from the banking sector, IT industry, and academia who were closely associated with blockchain-related initiatives in the banking sector across India. Expert selection was done in four stages. The first stage was the identification of institutions/organizations that are currently working on blockchain technology. The second stage was the identification of experts who are currently working/involved in blockchain-related projects. In the third step, we asked identified experts to participate. After they agreed to participate, they were asked to nominate other experts that they felt were worthy. Finally, when bringing together the appropriate expert panel, we ensured the greatest possible heterogeneity with regard to gender and related work areas. However, out of 30 experts, only 22 experts granted appointments to conduct semi-structured interviews. The selected panel included 16 males (73%) and 6 females (27%). Identified experts in the panel had varied backgrounds, such as vice president of marketing and corporate communication, business head of core banking and payment, technical experts, blockchain consultants and blockchain marketing experts along with experts from academia. These experts had a vast amount of information and knowledge on the benefits of implementing blockchain technology in banking and related sectors. Most of the interview sessions were conducted face to face at the expert's convenience at their

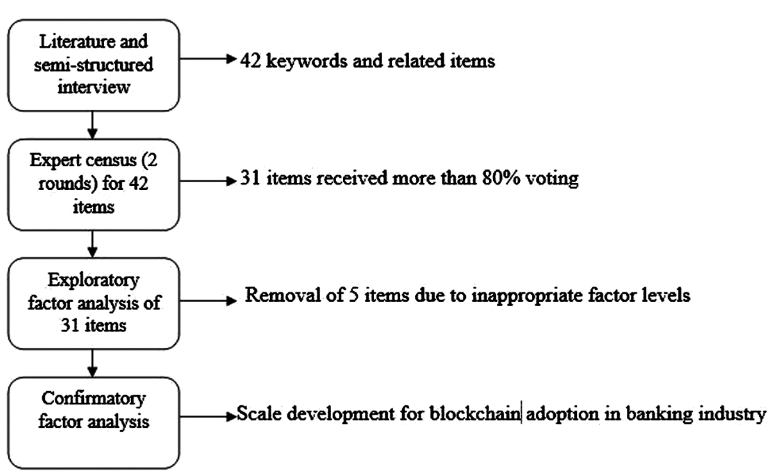

Fig. 2. Methodology adopted in the study.

respective offices, and three sessions were completed by phone. All the conversations were audio-recorded and analyzed separately for further research.

At the beginning of the interview, we briefed each panel expert in detail on the study purpose and objective and we asked six open-ended questions. Open-ended questions help reduce the chances of excluding items or issues that we as researchers may have omitted (Nworie, 2011). An unstructured questionnaire enables the experts to give an open response and allows plenty of room to elaborate on the topic under investigation (Pereira and Alvim, 2015). Among the selected six questions, three questions were openly linked to the benefits of implementing blockchain, such as: "*describe the 5 business benefits of implementing blockchain in the banking sector*" "*describe the purpose of blockchain in the banking sector*", or "*describe how blockchain will revolutionize the banking sector*". For the other three questions, we asked the subjects to provide details regarding the benefits of applying blockchain in their banking operations, such as *"what is the nature of your activities", "what challenges have you faced within the current system", or "what problems does blockchain solve"*.

Summarizing the wealth of qualitative data into useful and meaningful items was a critical and complex stage of the study. While conducting the qualitative content analysis on the first three questions, 42 different keywords were identified for describing the business benefits of adopting blockchain technology in the banking industry. Specifically, the responses to the first questions (i.e. describe the five benefits of implementing blockchain in the banking sector) allowed experts to respond freely based on their experience and as a result contributed valuable information to delineate the theme and items. Fig. 3 presents the framework used for the preliminary study and the outcome of this qualitative structure was used to develop a scale of the perceived benefits from implementing blockchain technology in the banking sector. Based on the qualitative outcomes, we developed 42 items indicating the perceived benefits of blockchain adoption in the banking industry.

3.2. Items and instrument development

Following a rigorous review of the existing literature and expert opinions, it was decided that 42 items would be included to identify the business benefits of implementing blockchain in the banking sector. We created an initial draft of a structured, closed-ended questionnaire containing 42 items (set of questions) identified from the literature review plus the qualitative research.

The experts were instructed to rate each of the 42 items for their importance and necessity in measuring the business benefits of implementing blockchain in the banking sector on a 7-point Likert scale (*1 – Not at all important, 2 – Low importance, 3 – Slightly important, 4 – Neutral, 5 – Moderately important, 6 – Very important, 7 – Extremely important*). In addition, the experts were asked to provide feedback/comments on clarity, ambiguity, wording, and content with regard to the items. Of the entire expert panel that was approached for the open-ended interview process, only 20 experts contacted to participate in refining the scale items agreed. A google documents direct link was sent to the experts to complete the questionnaire within two weeks' time.

Items for the instrument were selected based on a consensus of more than 80% (i.e. *very important, extremely important*). Out of 42 items, 28 items scored above 80. Based on the experts' score consensus, 28 items were important and appropriate for the research study. However, 14 items that scored less than 80% included comments for revision. The suggested revisions were made, and the 42 items were sent to the experts again to rate appropriateness. Consensus scores for each item were again calculated. Any item that did not score above 80% consensus was dropped. In the second round of rating, experts agreed that 31 items were appropriate and essential with no further revision required in the questionnaire. At each phase in the development of the questionnaire, the experts' opinion was taken. This helped with the step-by-step development and refinement of the survey instrument. We ensured face and content validity of the instrument through rounds of expert

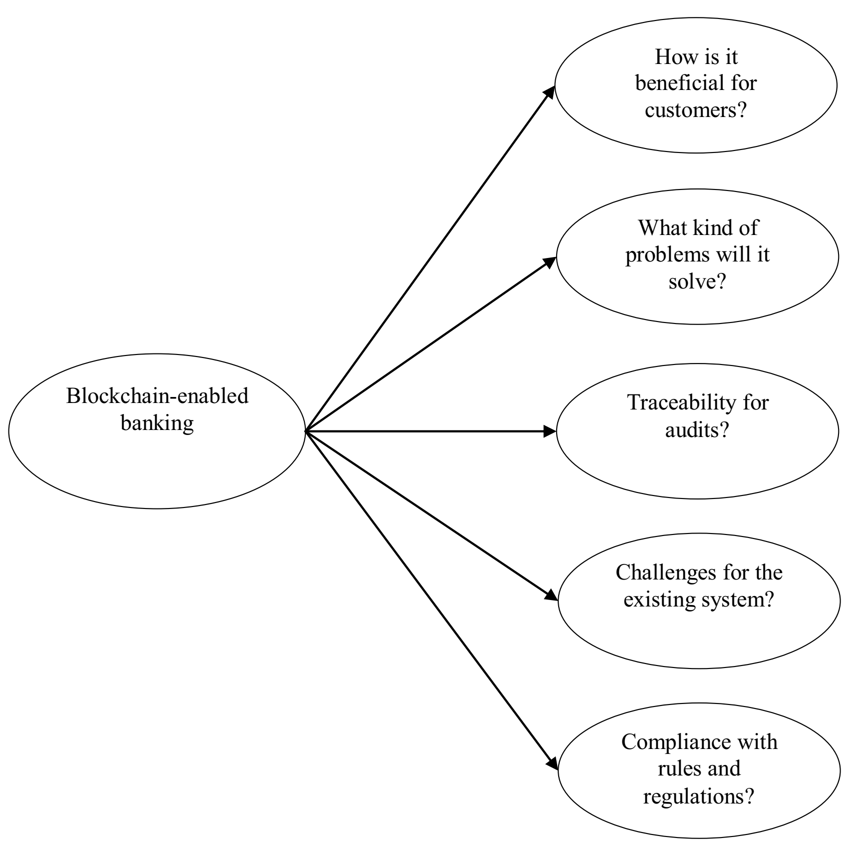

Fig. 3. Preliminary framework conceptualized for the qualitative study in 2017.

reviews.

3.3. Pilot testing - Refinement and finalization of the instrument

Dörnyei & Taguchi (2009) argued that "*questions that have been used frequently before must have been through extensive piloting*". In order to further validate the instrument, before actual data collection took place, we conducted a final pilot study with a relatively low sample size to measure the business benefits of adopting blockchain in the banking sector. The questionnaire was piloted with the responses from 150 blockchain consultants and blockchain marketing experts. The data was collected through a questionnaire and it was processed through a statistical package for the social sciences (SPSS 20) for factor analysis. The primary objective of using factor analysis was to refine the item pool. Factor analysis can be conducted in a number of ways and through various methods (Field, 2013). Kaiser (1974) and Costello & Osborne (2005) state that accepting loading values greater than 0.5 "*is reliable regardless of sample size*." After conducting the first factor analysis, five items were dropped from the measurement, because their factor levels were not considered vital as per Kaiser (1974), and we finally zeroed in on 26 items presented in Appendix 1, Part B.

The final draft of the questionnaire contained two sections. Section A contained 7 questions designed to define the respondent's profile. Section B contained 26 items designed to measure business paybacks of adopting and implementing blockchain technology in banking operations. The items were presented randomly as statements in the questionnaire. The items were measured using a 7-point Likert scale. We ensured the content and face validity of the instrument via experts.

3.4. Data collection

It is important to identify the list of prospective respondents for a survey-based study. Since our study is about the development of an instrument that may be used by future researchers to measure the benefits of blockchain, it is important to consider respondents who are in the forefront of and responsible for firm operations. We therefore decided to interview business heads. Apart from this, since the technology is in a formative stage, it was critical to include blockchain experts and consultants, as they have sufficient knowledge both of the functional and business part.

The questionnaire and a cover letter specifying the purpose and significance of the study were created on google docs and made available to blockchain technology consultants, blockchain marketing experts, and CEOs/business heads of banks who are currently in the process of consulting/implementing blockchain technology in the banking sector from April 2019 to November 2019. For the collection of data, we used the convenience sampling method. For this study, we followed a three-layered process. First, we contacted 600 experts and CEOs by phone from October 2018 to March 2019 to get a first-hand idea of whether their organization is considering or implementing blockchain for their operations. We followed a five-step approach to create the list of 600 experts: (i) we identified two sectors (public and private banking sector), (ii) we visited the websites of each bank, (iii) we identified the branches of banks in a particular area through search options on the website, (iv) we called the branch to understand its blockchain technology aspirations including who handles the vertical aspect of new technology implementation and asked for the e-mail and contact details of the person concerned, and (v) we were put in contact with blockchain consultants and marketers by bank executives. To shortlist these 600 experts, we applied the criteria of work experience (minimum of five years' experience in heading business verticals) and type of bank (public and private sector). We mentioned the objective of the study and benefits in terms of the findings of the study, which would be shared with them later. These findings can help them implement blockchain and improve integration in different areas. This resulted in 395 eligible candidates for the survey based on their profile and the blockchain orientation in their organization. Therefore, 395 survey questionnaires were sent out individually to the respondents, 320 of which were acknowledged at a response rate of 81 percent. Out of the 320, many of them had missing data values and a few were answered blindly. Filtering therefore resulted in 291 responses that were accurately complete and could be used for analysis. 291 responses were sufficient for this study with reference to the questions asked. We only required 130 responses, but received 291 (Bryant and Yarnold, 1995; Bentler and Chou, 1987). We could therefore proceed with further analysis in view of scale development.

3.5. Demographic profile

The details of the demographic profiles of respondents are presented in Table 2. There were a total of 291 respondents, with approximately 23.36% female respondents and 76.63% males. A majority of selected respondents (52.67%) were in the 35–45 age group and the remaining 47.33% were in the 25–35 age group. Approximately 42% of the respondents were management graduates with an MBA degree and 46% of them held a B. Tech./B.E. degree. The remaining 12% of the respondents were commerce graduates. About 14% of the respondents were CEOs/ business heads of banks followed by blockchain marketing experts (42%), blockchain consultants (35.33%), and others (8.67%). It should be noted that the maximum age of the respondents was found to be 45 years of age, since blockchain has emerged in the last decade. A limited pool of consultants, experts, and marketers is therefore available, particularly concerning those who are active in the banking industry. In addition, experienced executives beyond the age of 45 are primarily found at the strategic level rather than the implementation level of the technology. We were careful to check whether each respondent was aware of the disruptive blockchain technology and its benefits in the banking sector. It is clear from the profiles of the respondents that most of them were involved in blockchain implementation in their own areas and sectors.

4. Data analysis and results

The collected primary data was analyzed with the help of different validated statistical tools and procedures. Essential stages and steps required for the development of a measurement scale, such as confirmation of internal consistency and reliability of constructs, was ensured. This was followed by the factor analysis applied to the collected data. Furthermore, CFA was used to ensure the validity of the measurement scale. The outcomes of the analysis are discussed in the following subsections. We used SPSS 20 for EFA and AMOS 26.0 for CFA.

4.1. Reliability of the instrument

The quality of an instrument can be measured through its reliability (Broadbent et al., 2006). The reliability of an instrument is also a necessary requirement to ensure scale validity. The statistical reliability

Table 2
Demographic characteristics of respondents.

Demographic Variable	Categories	Response Rate
Gender	Female	23.36%
	Male	76.63%
Age Range	25–35 years	47.33%
	35–45 years	52.67%
Education	MBA	42.00%
	B.Tech./B.E.	46.00%
	Commerce Graduate	12.00%
Designation	CEO/Business head of banks	14.00%
	Blockchain marketing experts	42.00%
	Blockchain consultants	35.33%
	Others	8.67%

of an instrument is referred to as the degree to which scores from a test are stable and consistent. Therefore, in order to develop a reliable instrument, it is important to maintain the reliability of the instrument. There are a number of ways to test the reliability of an instrument, however, the internal consistency and reliability are easy to estimate and are generally found to be effective in the case of field studies (Rust and Cooil, 1994).

Internal consistency is a set of items or statements and the scale shows the degree to which these items are standardized or homogenous. The internal consistency and reliability of an instrument can be examined with the help of Cronbach's alpha (Sun and Hong, 2002). The value of Cronbach's alpha is acceptable if it is greater than 0.7, greater than 0.8 is considered good, and more than 0.9 is considered to demonstrate extraordinary internal consistency (Cronbach, 1951). In this study, the overall Cronbach's alpha value for 26 items was around 0.909, indicating that the identified items were reliable.

4.2. Exploratory factor analysis

Exploratory factor analysis (EFA) is a statistical technique for summarizing the information among observed variables into a smaller set of factors. The guidelines given by Straub et al. (2004) and Lewis et al. (2005) on validation suggested that factor analysis should be conducted with the help of EFA. This will help find and define the dimensions for the items measured. EFA is normally the first step in building scales. EFA is conducted to find the dimensionality of a theoretical construct (Iacobucci, 2010).

To understand the pattern and structure of data, all 26 items from Section B of the instrument were exposed to an EFA using principal components analysis (PCA) followed by a varimax rotation. The PCA begins by extracting the maximum variances and puts them into the first factor, whereas varimax rotation reduces the total number of variables with high loading against each factor and makes small loadings even smaller. Sampling adequacy was tested to identify the suitability of data

Table 3
Reliability and items loading.

Construct	Items	Description	Standard Factor loading	Cronbach (α)	Composite reliability	Average variance extracted (AVE)	Maximum shared variance (MSV)
Quality customer services	QCS1	Blockchain technology will improve transparency	0.762	0.872	0.873	0.579	0.166
	QCS 2	Blockchain technology will increase trust	0.734				
	QCS 3	Blockchain technology will increase data accuracy	0.803				
	QCS 4	Blockchain technology will reduce the risk	0.802				
	QCS 5	Blockchain technology will automate actions and transactions between parties	0.698				
Reduced cost	RC1	Blockchain technology will reduce transaction cost	0.805	0.867	0.869	0.624	0.166
	RC2	Blockchain technology will eliminate intermediaries	0.752				
	RC3	Blockchain technology will lower down administrative cost	0.726				
	RC4	Blockchain technology will lower down operational cost	0.870				
Efficiency and security	ES1	Blockchain technology will help in tracking real time business transactions	0.827	0.893	0.893	0.626	0.175
	ES2	Blockchain technology will increase speed of transaction	0.829				
	ES3	Blockchain technology will increase efficiency	0.784				
	ES4	Blockchain technology will enhance security	0.748				
	ES5	Blockchain technology will enhance the integrity of the system	0.764				
Secure remittances	SR1	Blockchain technology will create an immutable audit trail	0.778	0.892	0.893	0.582	0.175
	SR2	Blockchain technology will ensure a fast and secure payment process	0.746				
	SR3	Blockchain technology will enhance system resilience	0.762				
	SR4	Blockchain technology will enhance robustness	0.753				
	SR5	Blockchain technology will increase the traceability of transactions	0.782				
	SR6	Blockchain technology will increase the control on data	0.758				
Regulatory compliance	RCo1	Blockchain technology will streamline the business process	0.837	0.883	0.885	0.562	0.146
	RCo2	Blockchain technology will ensure immutable business rules	0.713				
	RCo3	Blockchain technology will prevent from financial fraud and tempering	0.742				
	RCo4	Blockchain technology will ensure data protection	0.704				
	RCo5	Blockchain technology will improve regulatory compliance	0.749				
	RCo6	Blockchain technology will reduce the error handling and reconciliation	0.744				

for factor analysis through Bartlett's test and the Kaiser-Meyer Olkin test. The estimated value of chi-square was 4174.095 with 325 degrees of freedom, indicating a significance level of 0.05. The KMO statistic of 0.875 is also large enough. The factor analysis conducted here can therefore be considered as a correct modus operandi to further analyze the data.

Twenty-six items related to measuring the benefits of implementing blockchain in the banking sector were factor analyzed using PCA with varimax (orthogonal) rotation. Tables 2 and 3 indicate the outcome of EFA and the definition of these factors. The analysis yielded five factors

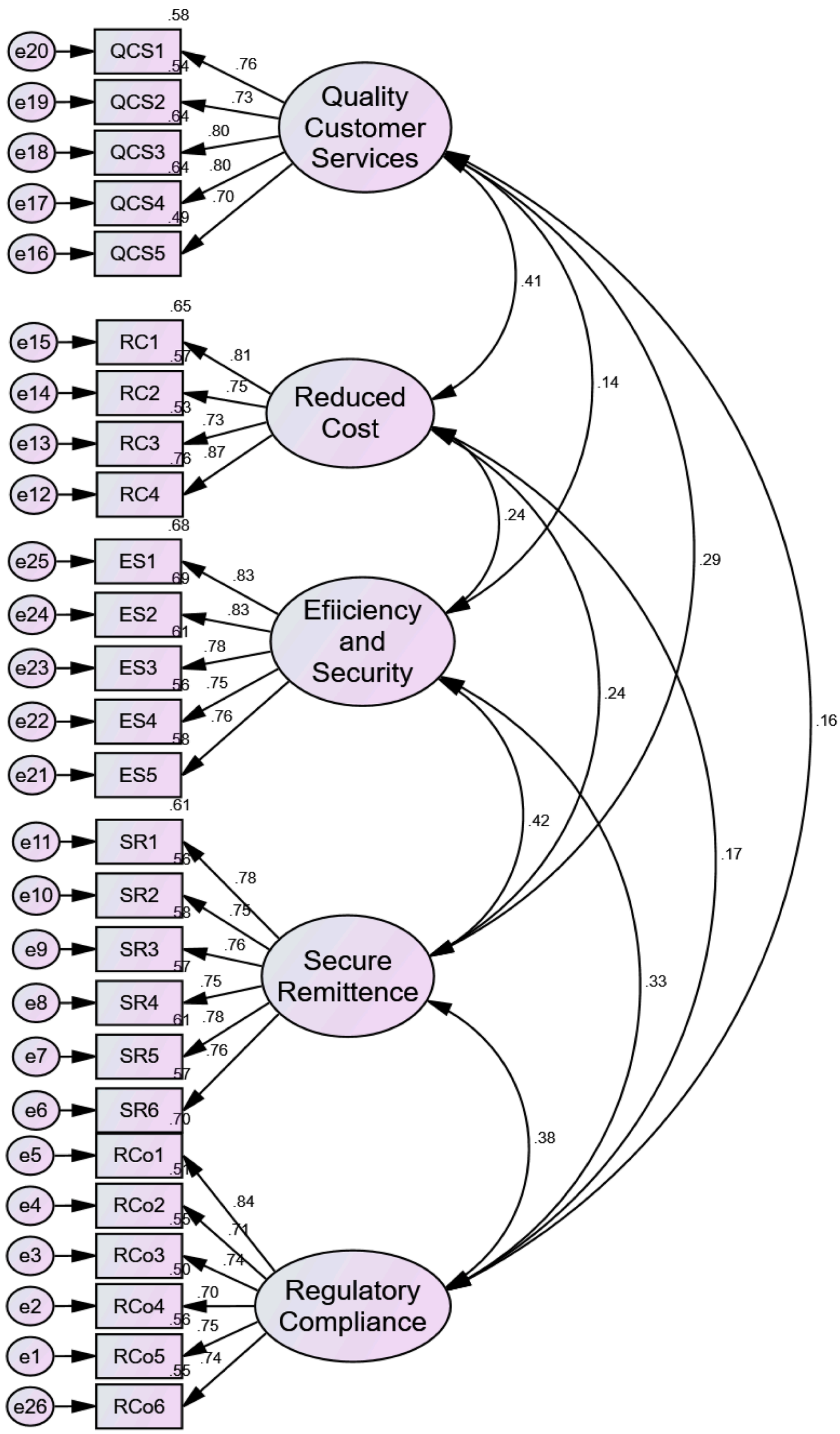

Fig. 4. Measurement model.

explaining a total of 67.535% of the variance. Factor 1 was labelled "*quality customer services*" due to the high loadings by items, such as: increase in transparency, increase in trust, data accuracy, risk reduction, and automation. The first factor was robust, with a high Eigen value of 2.403 and explained 12.869% of the variance. Factor 2 was labelled "reduced costs" due to high loading with the following items: reduced administrative costs, decreased transaction costs, elimination of intermediaries, and reduced operational costs. Factor 2 with an Eigen value of 1.898 explained 11.048% of the variance. Factor 3 was labelled "efficiency & security" due to high loading with the following items: real time, increased transaction speed, increased efficiency and ensuring the integrity of the system. The variance explained by this factor 3 was 13.657% with an Eigen value of 2.666. Factor 4 was labelled "secure remittances" due to the high loading with the following items: faster settlements, improved traceability, immutable data record, increased control of data, enhanced robustness, enhanced system resilience. The variance explained by this factor was 15.077% with an Eigen value of 7.131. Factor 5 was labelled "regulatory compliance" due to high loading with the following items: streamlining the business process, reduced fraudulent transactions, improved regulatory compliance, and ensuring immutable business rules and data protection. This factor explains around 14.883% of the variance with an Eigen value of 3.462. The five factors have been elaborated for better understanding and to show what their items indicate. F1: Quality customer services (QCS): The items in this factor are related to benefits of quality customer services offered by the banking sector. F2: Reduced cost (RC): The items in this factor are related to the benefits of reduced costs in the banking sector.

F3: Efficiency and security (ES): The items in this factor are related to the benefits of efficiency and security in the banking sector. F4: Secure remittances (SR): The items in this factor are related to the benefits of secure remittances in the banking sector. F5: Regulatory compliance (RC): The items in this factor are related to the benefits of regulatory compliance in the banking sector.

4.3. Confirmatory factor analysis

The proposed measurement model was examined with the help of CFA using AMOS 20. The purpose of examining the measurement model is to confirm the existence of the required level of construct reliability and validity before analyzing the inter-relationship of the constructs in the structural model (Ifinedo, 2006; Fornell and Larcker, 1981). The final measurement model indicating the different factors affecting the expected benefits of disruptive blockchain technology in banking operations is shown in Fig. 4. Constructs such as *"Quality customer services", "Reduced cost, efficiency, and security"*, "*Secure remittances"* and "*Regulatory compliance"* are showcased by five, four, five, six and six indicator items respectively. The constructs appearing in Fig. 4 were devised through the process of qualitative study (open-ended questions) followed by empirical study (closed-ended questions) and the structure was verified by EFA and CFA. Therefore, the five constructs indicating apparent business advantages of implementing blockchain technology in finance and the banking industry were measured through 26 indictors. The convergent and discriminant reliability of the measurement model were evaluated to investigate the psychometric properties (see Table 3).

Internal consistency measures the reliability of the different items included in the survey and is calculated with the help of the Cronbach alpha measurement (Streiner, 2003). The Cronbach alpha is an indicator calculated using a pairwise correlation between the selected items. The Cronbach alpha ranges from 0 to 1. It is estimated for the individual items of each construct in order to measure internal consistency (Table 3). A Cronbach alpha score ranging from 0.6 to 0.7 is considered the minimum required degree of reliability, and for a good degree of reliability it should exceed 0.7 (Taber, 2018). The different constructs included in the measurement model were found to have a decent level of internal consistency as the alpha value is 0.872 for the construct "quality customer services", 0.867 for "reduced cost", 0.893 for "efficiency and security", 0.892 for "secured remittances", and 0.883 for "regulatory compliance". Therefore, the included measures were found to be reliable and can be used in structural equation modeling (SEM) for further research. In our study, we used covariance-based SEM due to its ability to offer more verifiable characteristics and hence less bias in the estimated model (Mohamad et al., 2019).

To measure the reliability as well as the convergent validity of a construct in the measurement model, composite reliability (CR) can be tested. It offers a more reflective method of overall reliability and calculates the regularity of the construct itself including the firmness and similarity of the construct (Hair et al., 2010). A CR value of more than 0.7 indicates the presence of sufficient scale reliability (Nunnally and Bernstein, 1994; Fornell and Larcker, 1981). Table 3 indicates that the composite reliability of "*Quality customer services" is 0.873, "Reduced cost" is 0.869, "Efficiency and security" is 0.893, "Secure remittances" is 0.893* and "*Regulatory compliance*" *is 0.885*. Therefore, it can be determined that the combined reliability of each construct in the proposed model is more than 0.70, indicating that all constructs representing the perceived benefits of blockchain technology adoption in banking operations considered in the model have considerable reliability.

The convergent validity of a construct indicates the extent of item convergence or whether there is a high degree of disagreement overall (Hair et al., 2010). Convergent validity is also measured using standardized construct loadings. High values of standardized construct loadings indicate that the items of the construct are substantial and demonstrative of their construct. Standardized construct loadings to their observed variables should be more than 0.50 (Hair et al., 2010). The observed variable loadings in Table 3 were found to be in the range of 0.7 to 0.87. The results indicate that observed items are satisfactory and significantly represent their constructs. Therefore, we can ensure the presence of convergent rationality of constructs.

The degree to which a construct is different from other constructs indicates its discriminant validity (Hair et al., 2010). Two methods are used by researchers to analyze discriminant validity. The first is the correlation coefficient between the different pairs of constructs in the measurement model, which are also theoretically different and should not be high. This is due to the fact that different sets of items are used to measure different constructs. These items are expected to be different from each other and should therefore not be correlated too strongly (Trochim, 2006). Second, the average variance extracted (AVE) specifies whether the individual constructs in the measurement model are higher than the maximum shared variance of each construct and the square root of AVE and should be higher than the correlations between the constructs. Table 4 shows that "Quality customer services" has a small optimistic correlation with "Reduced cost", "Efficiency and security", "secure remittances", and "regulatory compliances" (0.407, 0.143, 0.289, and 0.164). However, "Reduced cost" has a low correlation with "Efficiency and security", "Secure remittances", and "Regulatory compliance" (0.242, 0.236, and 0.167). Similarly, "Efficiency and security" has little positive correlation with "secure remittances" and "regulatory compliance" (0.418 and 0.329). Finally, "secure remittances" has a small positive correlation with "regulatory compliance" (0.382). The low correlation between the constructs shows that all of the constructs included in the model are independent. Moreover, the AVE estimates indicate that the individual constructs are greater than their shared variances among the constructs (See Table 3). Furthermore, the square root of the AVE marked in bold (Table 4) is greater for diagonal constructs compared to non-diagonal constructs. These results indicate that each construct is highly interrelated with its items as compared to other constructs in the measurement model. Discriminant validity is therefore also found in the proposed measurement model.

The overall validity of the model was evaluated with the help of model fit indices such as the normed fit index (NFI), goodness of fit index (GFI), root mean square of error approximation (RMSEA), comparative fit index (CFI) and Tucker-Lewis Index (TLI) (Hair et al., 2010). The

Table 4
Correlation matrix and roots of AVE's.

	Quality customer services	Reduced cost	Efficiency and security	Secure remittances	Regulatory compliance
Quality customer services	**0.761***				
Reduced cost	0.407	**0.790***			
Efficiency and security	0.143	0.242	**0.791***		
Secure remittances	0.289	0.236	0.418	**0.763***	
Regulatory compliance	0.164	0.167	0.329	0.382	**0.749***

* The diagonal represents the square root of average variance extracted from observed variables (items); The off diagonal represents correlations between constructs.

goodness-of-fit indices for the measurement model are presented in Table 5. The respective values of $\chi 2$/df (1.604), CFI (0.956), GFI (0.895), NFI (0.893), TLI (0.951), and RSMEA (0.046) are presented in Table 5. Apart from the GFI and NFI, all the values were within the acceptable range. The tolerable values are $\chi 2/\text{df} \langle$ 3, NFI, GFI, CFI, and TLI $\rangle$ 0.9, CMIN/DF < 5, and RMSEA < 0.8 (Gefen et al., 2000; Gefen and Keil, 1998). The values of GFI and NFI are below the threshold value of 0.90, but they are very close to the threshold value, so these values also represent a satisfactory model fit. Table 5 clearly demonstrates that the measurement model is good fit.

5. Discussion

This study aims to develop and validate an instrument to measure perceived benefits of implementing disruptive blockchain technology in the banking sector. It has undergone a comprehensive systematic literature review and also includes knowledge obtained from interviews with blockchain experts to gain better insights to develop the items. Initially, we identified 42 items from the literature review supplemented with qualitative research. Results from the iterative instrument development and purification process confirmed the relevance of 26 out of 42 items. After applying suitable concepts and scale development techniques, items were grouped into 5 constructs as: "QCS", "RC", "ES", "SR" and "RCo". Based on the analysis of the statistical results, we defined each of the perceived business benefits. Customer services are the key to success for any business. Leveraging blockchain technology enables banks to build a new type of services for their customers, which can be built on the "quality customer services" construct. This construct has five items that offer enormous potential to change customer services for the better in terms of increased transparency, increase in trust, data accuracy, risk reduction, and automation. Implementation of blockchain in banking will enhance quality customer services by offering risk-free, tamper-proof, transparent, trustworthy, and accurate records to consumers indefinitely. One of the visible business benefits of implementing blockchain in a banking system is the reduction of overhead costs. Leveraging blockchain technology enables banks to lower overhead expenditures by significantly reducing costs, which can be based on the reduced cost construct. This construct has the following items: reduced administrative costs, decreased transaction costs, elimination of intermediaries, and reduced operational costs. The use of blockchain technology in the banking sector will lead to the elimination of intermediaries, thereby leading to reduced administrative and operational transaction fees. In banking systems, the security and efficiency of the operation is essential. Blockchain technology can be leveraged to build secure and efficient exchanges of financial transactions – which can be based on the "efficiency and security" construct. This construct has five items: real-time, increased transaction speed, increased efficiency, ensuring of system integrity, and increased security. Implementation of secure single blockchain networks in the bank will ensure real-time access, speed in processing paperwork, and high transaction speed, and this all leads to the ensuring of integrity. Secure remittances are another challenge for the banking industry and disruptive blockchain technology can be very helpful in terms of faster settlements, improved traceability, immutable data records, increased control of data, enhanced robustness and enhanced system resilience (Wamba and Queiroz, 2020). Yet another benefit of implementing blockchain in banks is to ensure regulatory compliance requirements effectively and efficiently. Blockchain technologies can improve private regulatory compliance, which can be based on the "regulatory compliance" construct. Therefore, it can help streamline the business processes, ensure a reduction in fraudulent transactions and improve regulatory compliance along with data protection. This set of perceived business benefits answers the first research question.

Table 5
Summary of goodness-of-fit indices for measurement model.

Model Fit Index	Chi-square/Degree of freedom	CFI	GFI	NFI	TLI	RMSEA
Model	1.604	0.956	0.895	0.893	0.951	0.046

In addition to the above perceived benefits, the banking industry can offer better products based on customer and market demand via the money circle that the bank caters to. Contractual performance can be observed in improvement parameters with the help of blockchain technology to settle the complex financial asset transactions that are bound by an incorruptible set of commercial rules. Every transaction is encoded and added to the distribution ledger to make it safe and secure with the identification of each stakeholder. A global network of blockchain technology can help the banking system transform the payments supply chain with the lowest risk of failure due to defined rights, controls, obligations, and standards (Palmié et al., 2020). Blockchain technology can be used in a plug-and-play manner in the existing and future networks of the system. In this study, we measured and validated the items through EFA and CFA, and these items or instruments can be used to quantify the paybacks of blockchain implementation. This answers the second research question. In terms of significance, blockchain technology can be very effective in reducing the cost of operations and improving customer services in the banking industry.

5.1. Research implications

Blockchain technology is still in its early stages of experimentation and testing for large systems. The main contribution of this study is to provide a foundation for future research in the field of blockchain. It is also worth noting that this study attempts to enrich the literature and contribute to blockchain related studies. A few studies that were not conducted in the banking industry per se but that concern blockchain implementation in general are available for comparison. Blockchain can be cost effective and help industries meet regulatory requirements. Furthermore, it can enhance the efficiency of banking operations via its traceability potential (Hastig and Sodhi, 2020; Min, 2019). Blockchain technology offers multiple benefits from smart contracts, renewals, and process optimization in the financial services and insurance sector in addition to core banking (Brophy, 2019). The cost of Ethereum blockchain is twice that of the traditional cloud services provided by Amazon SWF (Rimba et al., 2018). However, in another study in the energy sector, the authors claim that blockchain technology implementation helps promote trust, reduce costs for firm as well as customers, and enhance security (Noor et al., 2018). In another study, it was noted that digital rights management can be designed with the help of a trust model in blockchain (Ma et al., 2018). For the development and implementation of blockchain, it is essential to understand what professionals and end users think about the technology and its benefits. We found that the constructs and items match the reasons for blockchain implementation mentioned in the literature concerning closely-related industries (Hastig and Sodhi, 2020; Chaudhary et al., 2019; Meng et al., 2019). The provider and users can rapidly develop trust in digital banking, which can be done through blockchain enabled platforms (Dubey et al., 2020). Blockchain technology can be further integrated within a revenue department that maintains land records to ensure appropriate loan disbursement to build a house or any other type of construction (Thakur et al., 2020). Therefore, the development of an instrument to measure the benefits of implementing blockchain is a unique contribution of our study. The variables were identified from secondary sources and professionals and have been grouped into an appropriate construct through a structured process. Our validation of the instrument provides important insights from scholars and practitioners in the banking industry to better understand and advance research on the benefits of blockchain implementation. Scholars can extend this study by including new industries or banking-related industries such as insurance.

5.2. Practical implications

Our study outcomes offer fundamental insights for blockchain and banking professionals. One of the advantages of using blockchain for business is to streamline business operations by reducing unnecessary friction among diverse stakeholders. Blockchain enables an organization to develop trust and ensure transparency across business transactions. Since banking and related industries must handle large amounts of data, errors are common with traditional systems. Top executives in the banking industry can be sure of data accuracy and thus minimize the risks associated with data processing. Banking professionals can use blockchain to automate and renew transactions that are repetitive in nature across the stakeholders of a business. In this way, banking and other firms can employ blockchain technology to design customer-centric business activities and provide value-based services. Executives, experts and consultants in charge of cost reduction in the banking industry can consider implementing blockchain-based solutions to reduce administrative and operational costs. In the era of information and service excellence, it is necessary to keep track of real-time business transactions and enhance the efficiency of business operations. Practicing managers can implement blockchain technology to enhance the security and efficiency of their service ecosystem. In the banking industry, it is critical to have control over data, which must be further supported through system resilience. In certain situations such as humanitarian financial crises, blockchain can act as an enabler for the robustness and immutability of the audit trail, which is beneficial for both firms and auditors. As the banking industry deals directly with the finances of individuals as well as firms, it is prone to fraud and distortion of records. Executives can benefit from our study, since it recommends the application of blockchain to define business rules clearly and improve regulatory compliance. Furthermore, acting managers from the banking industry can deploy blockchain for record keeping, digital currency exchange, smart contracts, and security. Overall, professionals from different domains can consider the implementation of blockchain with respect to productivity in their business operations.

5.3. Limitations and scope for future research

The first limitation of the study is the sample size and geographic area. Data used for validation of the instrument came from 291 respondents, and although this was sufficient for the purposes of the study, it somewhat limits the generalization of the findings. Moreover, the instrument was empirically tested and validated using data from a single developing country. Future studies may consider whether the case study has robust claims. This again restricts the ability to generalize the findings. Testing the instrument in multiple countries would further develop and enhance its applicability. Such further work is necessary to prove the validity and confirm the generalization of the findings from this study. The instrument developed in this study can be used in further studies of blockchain implementation and their relationships with other organizational processes and outcomes, such as competitive advantage and organizational and operational performance in the banking sector.

6. Conclusion

Our study used a variety of validating procedures including an extensive literature review (for content validity) and scrutiny by a board of blockchain academics and experts (for face validity). In addition, we presented the developed items to three academics and five blockchain experts to see if their opinion was the same as that of the respondents. Pilot testing indicated a high degree of construct and content validity. The instrument developed consists of 26 items categorized into five constructs. Each item has a 7-point Likert scale for validation. We consulted 291 blockchain technology consultants, blockchain marketing experts, and CEOs/business head of banks in India for validation. This instrument has an acceptable level of reliability. The analysis and results of this study indicate that the instrument to measure the business benefits is highly reliable and demonstrate construct validity by accomplishing both convergent and discriminant validity. Our study contributes to both the theory and practice angles of blockchain technology in the banking industry. In terms of theory, our study delivers a validated instrument that aids managers in assessing the benefits of implementing blockchain in the banking sector. This instrument is explicitly crafted for the banking sector, though some of the benefits may be applicable to other sectors, as the study discusses benefits identified by working managers, experts, and researchers in the area of blockchain. The key points of the study are as follows: (i) it is of particular interest to acting managers/decision makers/experts to provide a foundational view to measure the business benefits of implementing blockchain technology before they choose to integrate blockchain in their banking system, (ii) the combination of professional and theoretical use results in the communal and technical relevance of this study. Furthermore, blockchain can be designed to suit the needs of a banking eco-system that will further help optimize the cost of launching it. These needs can range from rising costs of transactions, fulfilling regulatory requirements, enhancing efficiency and security, and satisfying customer with quick and transparent services.

Credit author statement

We submit Credit author(s) statement outlining individual contributions as follows:

Dr. Poonam Garg: Conceptualization, Methodology, and Writing-original draft

Dr. Bhumika Gupta: Formal analysis, Validation, and Resources

Dr. Ajay Kumar Chauhan: Software, Formal analysis, Investigation, and Validation

Dr. Uthayasankar Sivarajah: Resources, Writing-review & editing, Visualization, and Project administration

Dr. Shivam Gupta: Supervision, and Writing-review & editing

Dr. Sachin Modgil: Methodology, and Writing- original draft

Appendix: Questionnaire

We are trying to determine your perception to quantify the implementation of Blockchain technology in banking industry. Please click the number that is most appropriate for each item in the questionnaire. We are using 7-point Likert scale, where strongly disagree is represented by 1 and strongly agree is presented by 7.

Required- Part-A

Name of the Respondent
Organization
Department
Designation
Gender
Age range
Email ID

Required- Part-B

Blockchain technology will improve the transparency
Blockchain technology will increase the trust
Blockchain technology will increase the data accuracy
Blockchain technology will reduce the risk
Blockchain technology will automate actions and transactions between parties
Blockchain technology will reduce the transaction cost
Blockchain technology will eliminate the intermediaries
Blockchain technology will lower down the administrative cost
Blockchain technology will lower down the operational cost
Blockchain technology will help in tracking real time business transactions
Blockchain technology will upturn the speed of transactions
Blockchain technology will enhance the efficiency of operations
Blockchain technology will enhance the security
Blockchain technology will enhance the integrity of the system
Blockchain technology will create an immutable audit trail
Blockchain technology will ensure a fast and secure payment process
Blockchain technology will enhance the system resilience
Blockchain technology will enhance the robustness
Blockchain technology will enhance the traceability of transactions
Blockchain technology will rise the control of value chain on data
Blockchain technology will streamline the business processes
Blockchain technology will ensure immutable business rules
Blockchain technology will prevent from financial fraud and tempering
Blockchain technology will ensure the data protection
Blockchain technology will improve regulatory compliance
Blockchain technology will reduce the error handling and reconciliation

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