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What Drives the Adoption of the Blockchain Technology? A Fit-Viability Perspective

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ABSTRACT
Blockchain technology has the promise of transforming security and trust in digital transactions. However, concerns about technical complexity and the benefits of deployment have blunted its adoption. We examine factors that influence managerial intention to adopt blockchain technology. We extend the fit-viability model (FVM) and develop a value-based technology adoption model through an empirical study of 242 managers mostly in medical and financial industries. Managers in such organizations are likely to consider fit and viability in adopting blockchain technology to store and protect data. Drawing upon Fit-Viability and Task-Technology Fit models, and the Unified Theory of Acceptance and Use of Technology (UTAUT), we test a model with Partial Least Squares (PLS) to assess managers' intention to adopt blockchain technology. Our findings indicate that functional and symbolic benefits have positive impact on managers' assessment of task-technology fit. Furthermore, viability is an important criterion in adopting blockchain technology.

KEYWORDS
Blockchain; task-technology fit; environment-technology fit; fit-viability models; functional/symbolic benefits; blockchain adoption; technology adoption

Introduction

As an emerging technology, blockchain has the potential to change the way digital transactions are stored, retrieved, and shared. Blockchain refers to a secure decentralized ledger of serial, peer-to-peer transactions without third-party intermediaries [2]. The potentially significant advantages from blockchain technology are anonymity, transparency, security, traceability, and efficiency of transactions [30]. Although transparency and anonymity appear to be contradictory, transparency refers to an indelible record of transactions that can be viewed by anyone. Anonymity refers to the non-identifiability of the sending and receiving parties to the transaction because blocks of transactions that are saved and stored in nodes are coded as a set of English letters mixed with numbers as traders' names and are known only to the parties to the transactions. Some industries have applied blockchain technology, yet others remain on the sidelines because of uncertainty of business value [15] and have resisted adopting blockchain [67]. Therefore, blockchain adoption among managers, particularly in finance and medical industries, remains an important hurdle that needs further exploration.

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The information systems (IS) discipline has a rich tradition of theoretical and empirical research to assess the intention to adopt a new information technology (IT). Previous research has explored various facets of how technologies fit within the organization and its environment, for example, using the technology-organization-environment model (TOE) [36], technology acceptance model (TAM) [13], unified theory of acceptance and use of technology (UTAUT) [69], task-technology fit (TTF) [73], and value-based model (VBM) [66]. Previous adoption models measure factors relating to the context of technology, organizations, and the environment. However, we must also consider how the relationship among these three contexts affects the adoption of an IT because without a deeper understanding of the mechanism we may not be able to accurately interpret the varying effects of these factors that managers consider important when adopting new IT. For example, the relationship between technology and organization can generate insights into whether a technology's functional utility is suitable within the organization or the industry ecosystem vis-à-vis characteristics of task performance, business operations, and cost. Moreover, environmental factors, such as the competitive and regulatory pressures, may have a direct and profound effect on the adoption of IT. Therefore, it is essential to identify and incorporate these factors from a managerial perspective and form a robust conceptual framework for adopting blockchain technology in a strategic context. Understanding the managerial perspective will be helpful for researchers to construct a framework to expand the value of IT investments and for practitioners to make the business case for IT investment and to implement mechanisms to extract strategic value.

When adopting blockchain technology, managers should place high priority on the benefits and value created from IT. A key objective is the utility of the technology and whether it can facilitate the process of performing business tasks; for example, whether the adoption of a technology for cost reduction can redesign the operations and lower costs. Second, does the adoption of IT build business reputation and self-worth? For example, Wang [71] reported that firms associated with IT fashions had better reputation.[1] Similarly, herd behavior in IT adoption [59] and the fashion waves [6] are shown to be salient in adoption of IT. From this perspective, a firm's adoption of blockchain technology and its potential benefits are by no means unidimensional. Hence, further examination by developing with a research model that addresses the complexity of technology adoption is needed if we are to provide meaningful guidance to scholars and practitioners.

Among the theories for interpreting a firm's IT adoption, TTF focuses on whether the technology provides adequate functions to enhance the performance of the target task. Another approach is the feasibility/readiness model that focuses on whether the adoption of the technology is cost-beneficial and whether the organization has adequate resources to support the successful implementation of the adopted technology. The third model combines the fit and feasibility dimensions to propose a fit-viability model (FVM) [40]. This model is useful for adopting a new technology as fit and viability are combined to form an efficient framework to evaluate and examine factors of technology, organization, and environment in the adoption of IT. Moreover, top management in an organization primarily considers the benefits when considering adoption of new IT. In this study, we propose an expanded conceptual model, based on FVM that also incorporates benefits perceived by managers.

There are three reasons why we deploy an expanded FVM for analyzing blockchain adoption. First, blockchain is a new and groundbreaking technology but not yet widely used. Although there are several successful use cases, such as Maersk in shipping and Walmart in supply chain management, managers continue to seek ways to integrate blockchain-enabled capabilities with business strategy. Therefore, blockchain adoption can significantly impact the existing IT infrastructure, applications, and new services within organizations and across industries and managers must assess whether this new technology can better fit with their organization's information processing needs. Second, organizations and industry sectors must incur higher investments and bear greater risks when a revolutionary new technology is introduced. Therefore, sellers and adopters of blockchain must consider the cost-effectiveness and potential impact on the industry. Finally, blockchain technology is a complex technology for which most organizations have minimal prior exposure. Hence, whether the organizations have adequate IT capability and expertise is an important criterion in the adoption decision. The decision to adopt IT by outsourcing can also be important to pursue firm competitiveness (i.e., cost reduction and IT competence). We find that the FVM provides a more encompassing framework to study adoption than TTF and feasibility/readiness models alone.

Our purpose in this study is three-fold. First, by extending FVM to blockchain technology, our new model will examine managers' intention to adopt blockchain. Second, we investigate critical factors within organizations that may lead to the willingness to adopt blockchain. Third, we focus on medical and financial sectors because these organizations generate massive amounts of data from transactions, such data and business transactions need to be protected and preserved. By examining these two industry sectors, we explore to what extent, if any, industry type influences the intention to adopt blockchain technology.

The rest of the paper is organized as follows. Initially, in the literature review section, we discuss literature related to the theoretical arguments that shed light on technology adoption in organizations. These include the TOE model, FVM, TTF, VBM, innovation diffusion theory (IDT), and UTAUT. Next, we propose a research model and compose our hypotheses. Then, we describe our data collection, measurement, and analysis, followed by our findings from the analysis. Finally, we summarize our contributions and the practical implications, a brief description of limitations and future research, and conclusion.

Literature Review

Blockchain Technology

Blockchain is an emerging technology that underlies a series of peer-to-peer transactions to protect the transaction records, called blocks [77]. For protecting each block, blockchain technology utilizes time stamps, cryptographic hash, and data structures to prevent data or information from being tampered [45]. With such design features, blockchain technology provides several advantages, such as decentralization (function without intermediary), immutability (unchangeable and indestructible), anonymity (hidden real-world identity), traceability (irrefutable record), and security (smart contract) [82]. Such advantages can help address nagging problems that expose organizations across industries to unwanted risk. For example, anonymity and security can help prevent negative effects of deceitful buyers/sellers, cybercriminals, and detect financial fraud in electronic markets [60]. Therefore, blockchain technology has the potential to create value in a number of industries.

However, the technical disadvantages for blockchain have been identified such as throughput (inefficiency of transactions per second), latency (more time to complete transactions), size and bandwidth (large quantity of storage needed), security (risk of 51 percent attack, i.e., anyone having over half of the hashing power can control the chain), wasted resources (high energy consumption), usability (slow process with too many users), and versioning, hard forks, and multiple chains [61].

Among the disadvantages, throughput limitations can be significant. For example, transaction networks throughput for VISA is 2000 tps (transactions per second) and for Twitter is 5000 tps. However, throughput in a Bitcoin network reaches only 7 tps, indicating low throughput in database management [75]. Second, in terms of latency, VISA only took a few seconds to complete a transaction, whereas blockchain needs approximately 10 minutes to add a block [61], an indicator of inefficient transaction processing. Third, as blockchain size increases, larger amount of storage will be needed. For example, the Bitcoin blockchain consumes over 170GB on each network node [19], indicating large consumption of data storage. Such limitations need to be overcome to offer better solutions in the future.

The technical limitations notwithstanding, blockchain technology has garnered interest from managers across many industries. In the healthcare field, there is a need to store and share secure medical data. Blockchain can serve as the underlying technology within integrated systems to verify authenticity of drugs flowing through the pharmaceutical supply chain, monitor medical history exchanges among physicians and hospitals, and to pass health data directly to Content Management System (CMS) [47] for personalization of patient treatment. In banking and finance, financial transactions require features that are secure, distributed, consensus-driven, and trust [21]. Therefore, blockchain technology adoption can fulfil the needs for security in information exchange between firms in financial and medical fields.

Recent blockchain research has identified the importance of its distinctive features and positive impact on the computer network and IS. For example, development of blockchain technology related to finance includes blockchain-based fair payment in the cyber physical system [80], Bitcoin, Ethereum, and other cryptocurrencies [77], cloud storage systems in data sharing [72], smart contracts for financial assets [76], and bilateral double taxation for international transactions [29]. Similarly, healthcare firms demonstrate the significant opportunities in using features of blockchain technology, for instance, in medical insurance storage system [81], medical data such as diagnosis certificates and medical records [38] medical database [32], electronic health records [12], and patient-owned medical apps [78].

Despite the potential applications of blockchain technologies across industries and the benefits reported in the literature, especially in cryptocurrencies such as Bitcoins, Ethereum, and Hyperledger, the potential of blockchain is yet to be exploited. Managers seek assurance about the maturity of the blockchain technology and the scalability needed to support reliable business processes. Cullell [11] outlined the obstacles that businesses face in adopting blockchain technology. These include limited scalability to support the volume of transactions even for cryptocurrencies, network congestion, and low efficiency in processing blocks that make real time transactions difficult to execute, and the lack of data transparency, especially among private blockchains. Hence, managers view blockchain technology as having high potential but are cautious to adopt until they perceive a fit with the business goals.

Technology-Organization-Environment (TOE) Model

TOE model refers to three contexts that enterprises consider in the adoption of technology: technological, organizational and environmental [63]. The technological context refers to actual and potential technology competence to benefit the firm [4] and includes compatibility, complexity, and trialability [49]. The organizational context is defined as formal and informal resources that reinforce adoption of technology, such as top management support, organizational readiness, and financial backing [55]. Environmental context refers to the external environment that presents pressures and/or support for adoption of technology, such as industry competition, government support, and consumer readiness [49]. The TOE model provides a useful framework and a theoretical basis to investigate factors that influence managerial decisions regarding adopting technological innovation.

consumer readiness

Fit-Viability model (FVM)

FVM originated from Tjan [62] and later was modified to evaluate how, and in what conditions, an organization adopts a new electronic technology [40]. Fit refers to the extent to which technology competence can match or be suitable to perform tasks in an organization [39], adding value to network applications, and human resources. Fit proposed the significance of the relationship between IT and the task to which it is applied within an organization. Liang and Wei [40] proposed that the combination of technology and task had become a vital factor for enhancing organizational productivity and profitability.

After the technology has fulfilled the requirement of task performance, the organization should consider the viability within the organizational environment. Viability refers to measuring costs, benefits, and readiness to use within the organizational environment if it were to adopt a new technology [37, 40]. This includes measuring whether adopting a new technology needs essential support of economic feasibility, technical equipment, and social readiness within an organization [65]. Given that the aforementioned factors to adopt a technology in an organization are of significant importance, we draw upon the FVM for our study.

Fit and viability are two core dimensions of the model that yield four categories in a matrix when high/low levels of fit and viability are mapped. These four categories generate four types of strategies for adoption of IT, labeled as good target (high on fit, high on viability), organizational restructuring (low on fit, high on viability), finding alternative technology (high on fit, low on viability), and forget it (low on fit, low on viability) [40] Hence, the preferred strategy for adoption is when the technology under consideration is high on both fit and viability.

Task-Technology Fit (TTF)

Similar to the tenets of the FVM previously discussed, TTF is important for IS adoption as the technology must match the task within an organization and, therefore, generate performance impact(s) [23] such as carrying out tasks easier, faster, and more efficiently. Task and technology fit can be categorized into task and technology characteristics. Task characteristics refer to challenging activities that an individual using IT may encounter. Technology characteristics are machinery or equipment designed for successful completion of various tasks [3]. Fit focuses mainly on performance only due to linkage between functions of technology and requirements of tasks [23].

Value-Based Model (VBM)

VBM refers to the evaluation of importance, usefulness, and the worth of a product in comparison with acquisition and detriment [34]. Assessment of overall value of a product can be classified into two core parts: perceived benefit and perceived sacrifices [79]. Perceived benefits refer to anticipated advantages brought from product performance while perceived sacrifices refer to cost and effort an individual spends to acquire a product [54]. Both perceived benefits and perceived sacrifices are central to form an overall value according to perceived quality and monetary price [34]. Benefits play an important role in the intention to adopt IS and therefore motivate us to adopt VBM perspective in our study.

Functional/Symbolic Benefits

Business value of IT refers to the benefits that emerge from the combination of IT with organizational resources that create and sustain competitive advantage for a firm [8]. Business value generated through adoption of IT is categorized as functional and symbolic [42]. We refer to this as the dual value model (DVM). Functional benefit refers to improved organizational performance through adoption of new IT, such as productivity, profitability, and efficiency [5]. In the marketing context, functional benefits reflect product-related attributes that generate the product's utility to users [42]. Functional benefit represents a good fit between technology and organizational tasks [24]. Fit, in this context, represents how well the new technology matches the core capability, value and culture of the organization.

Symbolic benefit refers to positive effect brought by adoption of new technology, (e.g., brand image, organizational innovation and company reputation) [24]. Such positive effects can be witnessed by market response, which is a signal of technological innovation for the firm [58] and impact on the stock price [24]. Symbolic benefits can cause herd behavior when a firm follows others' lead and adopts a new technology, even though it introduces uncertainty [59]. Symbolic benefits represent a fit between technology and the organizational environment [24].

Both functional and symbolic benefits form a matrix to illustrate the four alternatives for adoption of IT, with functional benefit as horizontal axis and symbolic benefit as the vertical axis [24]. Four strategies are identified as image builder, strategic transformer, reactive defender, and performance enhancer [24]. For example, when both functional and symbolic benefits are high, IT helps generate value by creating a positive image for the firm. If both are low, the firm should adopt defensive mechanisms rather than pursue IT performance.

Innovation Diffusion Theory (IDT)

IDT explains how new ideas, things, and methods are introduced to individuals, how and when individuals react or interact with such innovation spread across a social system [1]. IDT emphasizes two crucial parts: the speed of diffusion of the innovation and factors that result in the adoption of innovation. For the speed of diffusion, the process of diffusing an innovation begins slowly and later accelerates to necessity due to the declining degree of uncertainty from the innovation [53]. As for when to adopt the innovation, five types of individuals influence time to adopt an innovation: innovators, early adopters, early majority, late majority, and laggards [68]. Moreover, factors that show the willingness of adopting an innovation are relative advantage, compatibility, complexity, trialability, and observability [68]. This literature emphasizes the timing and willingness to adopt an innovation, two important aspects of blockchain adoption that prompted us to include this theory into our study. In this theory, technology adoption is influenced by two factors: advantages of the technology and perception of potential users.

Unified Theory of Acceptance and Use of Technology (UTAUT)

UTAUT is an integrated model with four core determinants and four moderators in intention-usage relationship [69]. Designed specifically to theorize the adoption of a technology, UTAUT proposes that self-benefit considerations closely connect with the four key constructs such as performance expectancy (gain in job performance), effort expectancy (ease of usage), social influence (advantage for social image), and facilitating conditions (available resource support) [70]. To make UTAUT more adoptable in consumer context, Venkatesh et al. [70] modified UTAUT by adding cost considerations, one motivation factor, and one behavior factor in the model, including price value (cost), hedonic motivation (pleasure), and habit (prior behavior) [70].Therefore, UTAUT can explain a wide array of user intentions and behaviors regarding information system adoption.

Among the moderating factors, the four determinants with intention-usage relationship is the previous experience with inferior technology which restrains individuals from usage of new technology [74]. Furthermore, social influence in mandatory contexts becomes significant in early adoption of new technology and eventually insignificant over time [69].

social influence
experience

Table 1. Summary characteristics of relevant theories.

Theory	Theme	Study Objective	Limitations
Technology-Organization-Environment (TOE)	Direct effect of technological, organizational, and environmental factors	Direct effect	No consideration of factor interaction
Task-Technology Fit (TTF)	Fit between task characteristics and technological features	Alignment	Lack of environmental factors and organizational readiness
Fit-viability model (FVM)	Combination of TTF and feasibility	Hybrid	Lack of Environmental factors
Value-based Model (VBM)	Rational choice of cost benefits	Economic	Weak in TTF and environmental factors
Dual Value Model (DVM)	Differentiation of functional and symbolic values	Value Classification	Weak in TTF and environmental factors
Innovation Diffusion Theory (IDT)	Technology features and the diffusion process	Process view	Lack of interaction effects
Unified Theory of Acceptance and Use of Technology	Benefit and cost considerations and individual differences	Marketing	Weak in organizational contexts

In Table 1, we summarize the core concepts drawn from theories previously cited and how each informs our framing of a model for analyzing the blockchain technology adoption. We find that each model has its advantages and limitations. In particular, the column "Theme" indicates that each theory base addresses different aspect(s) of the adoption phenomenon and that integration among these models is needed.

In practice, the decision makers must take into consideration technological, organizational, and environmental factors, along with various types of opportunities and benefits that the new technology can generate that were not feasible without the technology. Hence, it is important to propose and test a model that integrates previous models and examines the factors and values that managers expect from adoption of a new technology, such as blockchain.

Hypothesis

TTF refers to the capacity of new technology to match with task demands, which can make task completion faster, more efficient, and, therefore, reduce cost. Recent findings indicate that high TTF can greatly improve task performance in learning management systems [44] and speed, efficiency, and cost are key factors of functional benefits [7]. A combination of both IT and organizational capabilities can be the foundation for achieving business value with digital technologies or "Digital Business Value" [51]. Therefore, we hypothesize that TTF will enhance functional benefits from blockchain technology.

Hypothesis 1 (1): Task-technology fit is positively related to functional benefits for using blockchain technology.

Environment-technology fit (ETF) refers to factors from the environment that can influence businesses to adopt a new technology [46]. When competitors use a new technology (e.g., blockchain technology), others will experience competitive pressure and adopt the new technology. To adopt a new technology, businesses must maintain competitiveness [41], which brings extrinsic advantages such as innovation, social influence, and positive image for businesses. Such advantages are key concepts of symbolic benefits. Demlehner and Laumer [14] also found that context is important in digital transformation of manufacturing industry. Therefore, we hypothesize that ETF will increase symbolic benefits for blockchain technology.

Hypothesis 2 (H2): Environment-technology is positively related to symbolic benefits for using blockchain technology.

Functional benefits refer to product-related benefits that meet firms' needs after consuming a product or service [33]. A new technology (i.e., blockchain technology) can contain technology-related benefits, which attract a business to adopt it, such as anonymity, transparency, security, traceability, efficiency, and speed [30]. When businesses know and understand such practical advantages, they assess the effects of these advantages, prompting the business to use the new technology. Therefore, functional benefits are positively related to intention to use blockchain technology. We thus hypothesize the following:

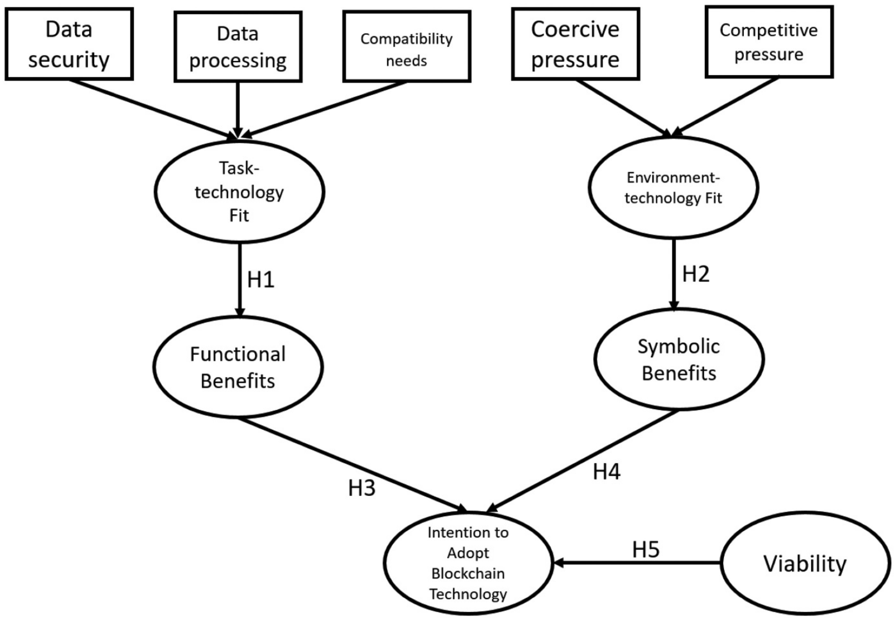

Figure 1. Research model.

Hypothesis 3 (H3): Functional benefits are positively related to the intention to adopt blockchain technology.

Symbolic benefits refer to non-product-related benefits that firms perceive after consuming a product or service [33]. Non-product-related benefits include perception of self-realization such as self-esteem, social approval, social image, and self-concept [31]. Applying this concept to blockchain technology, the use of blockchain technology can benefit by enhancing the social image and social approval for businesses, so they will consider and acquire the new technology. We thus hypothesize that:

Hypothesis 4 (H4): Symbolic benefits are positively related to intention to adopt blockchain technology.

Viability refers to the degree to which a plan, suggestion, or idea that is possible and likely to be done or be successful [65]. A plan, suggestion or idea to adopt a new technology (i.e., blockchain technology) needed support of financial resources, essential equipment and machinery to operate, and top management support [39]. When the support is strong, businesses show interest and think the plan, suggestion, or idea is achievable. Therefore, businesses may demonstrate intention to adopt blockchain technology when they view the technology as viable. We thus hypothesize H5 as follows:

Hypothesis 5 (H5): Viability is positively related to intention to adopt blockchain technology.

In Figure 1 we graphically represent our framework and the hypotheses.

Methods

Sample and Data Collection Processes

Our data collection involved an online survey from May 2018 to June 2018. The survey was completed by 251 informants. The invitations to the informants were posted on online forums related to financial technology, the stock market, and medical institutes. Participants were instructed to rate items in our survey based upon their perception. Nine responses were determined to be invalid because of repeated participation and/or indiscriminate responses, leaving 242 responses as valid and suitable for further analysis. Our sample covers informants from a broad range of professional expertise, including IT, medical, financial, and others, indicating a good representation of decision-making groups that adopt new technology. Table 2 shows the profile of the respondents in our sample.

Table 2. Respondent profiles.

Respondents	Numbers in Sample	Percentage (%)
Industry		
Finance	76	31.4
Medical	88	36.4
Manufacturing	22	9.1
Information	18	7.4
Technology	13	5.4
Public service	9	3.7
Public utility	16	6.6
Others	242	100.0
Total		
Job Title		
Doctor	47	19.4
Nurse	29	12.0
Engineer	49	20.2
Manager	16	6.6
Supervisor	36	14.9
Middle-ranked officials	10	4.1
Senior executive	8	3.3
Others	47	19.4
Total	242	100.0
Tenure		
Below 1 (year)	49	20.2
1-5 (under)	98	40.5
5-10 (under)	35	14.5
10-15 (under)	20	8.3
15-20 (under)	18	7.4
Above 20	22	9.1
Total	242	100.0
Department		
Information Technology	41	16.9
Medical	80	33.1
Research & Development	19	7.9
Financial	28	11.6
Human Resource	6	2.5
Planning	7	2.9
Management	22	9.1
Sales	13	5.4
Others	26	10.6
Total	**242**	**100.0.**

Table 3. Constructs and items.

Construct	Item
Task-technology Fit Data Security Data Processing Needs Compatibility	Aljukhadar et al. (2014) [3]; Goodhue (1998) [22], and Soliman and Janz (2004) [57] • Security of blockchain technology can satisfy the need of information management. • Security of blockchain technology can satisfy the need of privacy on information management. • Speed of blockchain technology to information processing can satisfy the need of efficiency. • Speed of blockchain technology can satisfy the need of updating information processing. • Tamper-proof of blockchain technology can satisfy the need of information correctness. • Tamper-proof of blockchain technology can satisfy the need of not being forgery. • Preventing any third party involvement for blockchain technology can satisfy the need of improving information delivery. • Sharing for blockchain technology can satisfy the need of information integration. • Sharing for blockchain technology can satisfy the need of authorizing to other organizations.
Environment-Technology Fit Competitive Pressure Coercive Pressure	Gholami et al. (2013) [20]; Liang et al. (2007) [39]; Premkumar and Ramaurthy (1999) [48] • Blockchain technology can satisfy the need of competitive market strategies. • Many competitors have adopted blockchain technology • Using blockchain technology can satisfy the need of customers. • Using blockchain technology can satisfy the need of government regulations. • Using blockchain technology can satisfy the need of official association. • Using blockchain technology can satisfy the need of partners.
Functional Benefits	Doll and Torkzadeh (1998) [16]; Ravichandran and Lertwongsatien (2005) [50] • Application of blockchain technology can enhance the quality of management • Application of blockchain technology save time of management. • Application of blockchain can enhance the productiveness. • Application of blockchain technology can lower the cost of operation. • Application of blockchain technology can improve financial performance.
Symbolic Benefits	Hsu et al. (2007) [27]; King and Teo (1996) [35] • Application of blockchain technology can enhance reputation • Application of blockchain technology can improve fame. • Application of blockchain technology can increase influence among peers. • Application of blockchain technology can boost prestige. • Application of blockchain technology can enhance image of innovation. • Application of blockchain technology can promote leadership among peers. • Application of blockchain can acquire recognition among peers, partners, shareholders, and government.
Viability Financial Resources	Kuan and Chau (2001) [36]; Liang et al. (2007) [39]; and Lin (2014) [41] • It is likely to Investing funds to adopt blockchain technology. • It is likely to investing funds to operate and maintain blockchain technology. • It is likely to investing funds to the cost of job training on blockchain technology.
IT Infrastructure	• Essential hardware can be operating with blockchain technology. • Essential software can be operating with blockchain technology. • Data base can be compatible with blockchain technology. • IS personnel can maintain and develop blockchain technology. • Systems can integrate with blockchain technology.

(*Continued*)

Table 3. (Continued).

Construct	Item
Top Management	• Top management is interested in adopting blockchain technology. • Top management has adequate financial resource to adopt blockchain technology. • Top management is aware of benefits of adopting blockchain technology. • Top management will consider adopting blockchain technology to form a project team.
Intention to Adopt Blockchain Technology	Tsai et al. (2013) [64] • Intention to adopt blockchain technology is the first stage for adopting the blockchain technology. • Willingness to use blockchain technology is the stage before full adoption. • High intention to adopt blockchain technology

Measurement

The items measuring TTF were drawn from Aljukhadar et al. [3]; Goodhue [22]; and Soliman and Janz [57]. Items measuring ETF were drawn from Gholami et al. [20]; Liang et al. [39]; and Premkumar and Ramaurthy [48]. Six items to measure functional benefit were drawn from Doll and Torkzadeh [16] and Ravichandran and Lertwongsatien [50], while seven items of symbolic benefits originated from Hsu et al. [27] and King and Teo [35]. Items measuring viability were adopted from Kuan and Chau [36]; Liang et al. [39]; and Lin [41]. Items measuring intention to adopt blockchain technology were drawn from Tsai et al. [64]. The survey adopted a Likert scale from 1 (strongly agree) to 5 (strongly disagree), and all scores were averaged to express the level of the construct. Table 3 shows the construct and items in this study.

Analysis Results

Reliability and Validity Testing

The measurement model uses partial least squares (PLS) to assess reliability, convergent validity, and discriminant validity to measure the fitness of this model. To test reliability, we adopted composite reliability and Cronbach's alpha as the standard of measurement [25]. Table 3 shows that item assessing each construct had Cronbach's alpha > .753 and composite reliability > .885, indicating acceptable reliability. Moreover, an average variance extracted (AVE) > .573, showing sufficient reliability. Table 4 shows the results.

In the analytical results of validity, all factor loadings were above .07 and AVE was between .57 and .88, indicating adequate convergent validity [18]. The square root of AVE for each variable had a value greater than correlated variables in each column and row, indicating acceptable discriminant validity. Furthermore, the value of correlation coefficients was lower than .85 in each dimension. In a cross-loading matrix, factor loadings for each item in each dimension are larger than other factor loadings in other dimensions, suggesting sufficient discriminant validity [9]. Tables 5 and 6 show the correlation and cross-loading results.

As our model includes formative constructs and the sample size is relatively small, PLS-SEM is considered appropriate to analyze the data [52]. We used SmartPLS to analyze model validity, including coefficient of determination (R^2), path coefficients, effect size (f2),

Table 4. Results of composite reliability, Cronbach's alpha, AVE.

Construct	Dimension	Items	Composite Reliability	Cronbach's Alpha	AVE
	FR	3	0.955	0.929	0.876
Viability	TM	4	0.934	0.905	0.779
	IT	5	0.964	0.953	0.842
Symbolic Benefits		7	0.945	0.932	0.709
Intention to Adopt Blockchain Tech		6	0.958	0.934	0.884
Functional Benefits		3	0.923	0.900	0.666
Environment- Technology Fit	OP	3	0.885	0.804	0.720
	CP	3	0.861	0.759	0.675
	DS	2	0.919	0.823	0.850
Task-Technology Fit	DN	4	0.841	0.753	0.573
	CO	3	0.894	0.823	0.739

Notes: AVE, average variance extracted; FR, financial resources; TM, top management; IT, information technology infrastructure; OP, coercive pressure; CP, competitive pressure; DS, data security; DN, data processing needs; CO, compatibility.

Table 5. Construct correlations.

	AI	CO	DN	DS	FB	IT	CP	OP	FR	SB	TM
AI	0.940										
CO	0.385	0.860									
DN	0.533	0.668	0.757								
DS	0.356	0.591	0.550	0.922							
FB	0.695	0.616	0.737	0.442	0.816						
IT	0.732	0.259	0.440	0.268	0.576	0.918					
CP	0.651	0.604	0.696	0.536	0.794	0.497	0.822				
CO	0.603	0.611	0.670	0.574	0.767	0.529	0.807	0.848			
FR	0.638	0.374	0.490	0.390	0.530	0.633	0.458	0.471	0.936		
SB	0.647	0.538	0.637	0.541	0.696	0.477	0.710	0.738	0.475	0.842	
TM	0.791	0.373	0.544	0.306	0.642	0.764	0.597	0.597	0.694	0.565	0.883

Notes: AI, intention to adopt blockchain technology; CO, compatibility; DN, data processing needs; DS, data security; FB, functional benefits; IT, information technology infrastructure; CP, competitive pressure; OP, coercive pressure; FR, financial resources; SB, symbolic benefits; TM, top management.

and predictive relevance (Q^2). The value of R^2 for functional benefits (FB), symbolic benefits (SB), and intention to adopt blockchain technology (AI) are .56, .58, and .73, respectively, which can explain a large amount of variance and such values are considered as between moderate and substantial [9]. Path coefficients between variables were also analyzed. The results show TTF →FB (.75), ETF→ SB (.76), FB→ AI (.17), SB→ AI (.19), and VI→ AI (.60) [28]. In terms of effect size, all three independent latent variables have an impact on a dependent latent variable. The value of f2 are FB→ AI (f2 = .046), SB→ AI (f2 = .064), suggesting low effect whereas VI→ AI (f2 = .668) indicates large effect in the structural model [10]. Q^2 refers to a measure of the predictive relevance of manifest variables. The results of our analysis show that FB→ AI ($Q^2 = .297$), SB→ AI ($Q^2 = .370$), and VI→ AI ($Q^2 = .604$), suggesting $Q^2 > 0$ and meeting the proposed threshold value [17]. Table 7 shows the results.

Path Analysis

We used PLS to analyze the proposed model and hypotheses, which generate the parameters of measurement model and path coefficients. Figure 2 summarizes the results of bootstrapping to test for each hypothesis and t value. In the results of bootstrapping, data security are negative and insignificant (t = .428, p = .669). The reason may be that the

Table 6. Cross loadings.

	AI	CO	DN	DS	FB	IT	CP	OP	FR	SB	TM
AI1	0.953	0.372	0.498	0.37	0.652	0.675	0.627	0.572	0.609	0.629	0.747
AI2	0.938	0.348	0.5	0.299	0.662	0.663	0.595	0.53	0.578	0.575	0.721
AI3	0.929	0.365	0.505	0.334	0.646	0.725	0.613	0.597	0.61	0.621	0.762
CO1	0.34	0.855	0.627	0.533	0.556	0.227	0.551	0.567	0.294	0.551	0.331
CO2	0.339	0.907	0.601	0.521	0.573	0.229	0.561	0.56	0.347	0.457	0.327
CO3	0.312	0.814	0.482	0.467	0.446	0.212	0.433	0.436	0.326	0.363	0.302
DN1	0.466	0.535	0.843	0.411	0.645	0.425	0.552	0.506	0.38	0.407	0.471
DN2	0.468	0.585	0.835	0.376	0.645	0.429	0.574	0.526	0.391	0.42	0.47
DN3	0.353	0.44	0.675	0.414	0.453	0.22	0.498	0.486	0.342	0.578	0.336
DN4	0.297	0.451	0.653	0.512	0.45	0.198	0.486	0.537	0.384	0.613	0.348
DS1	0.355	0.556	0.53	0.929	0.425	0.232	0.499	0.525	0.368	0.522	0.29
DS2	0.299	0.533	0.482	0.914	0.388	0.265	0.49	0.534	0.349	0.473	0.272
FB1	0.58	0.37	0.487	0.278	0.798	0.537	0.639	0.583	0.393	0.497	0.53
FB2	0.583	0.415	0.553	0.33	0.829	0.494	0.676	0.636	0.409	0.601	0.506
FB3	0.654	0.448	0.562	0.297	0.851	0.59	0.656	0.626	0.442	0.547	0.6
FB4	0.528	0.582	0.649	0.428	0.808	0.373	0.687	0.651	0.439	0.611	0.478
FB5	0.508	0.597	0.702	0.38	0.81	0.363	0.62	0.622	0.389	0.536	0.452
FB6	0.554	0.579	0.639	0.438	0.802	0.476	0.611	0.636	0.519	0.609	0.581
IT1	0.653	0.182	0.378	0.214	0.481	0.911	0.387	0.429	0.577	0.423	0.683
IT2	0.7	0.219	0.423	0.252	0.509	0.929	0.46	0.489	0.606	0.464	0.707
IT3	0.67	0.21	0.396	0.268	0.533	0.91	0.45	0.476	0.593	0.435	0.692
IT4	0.646	0.261	0.366	0.228	0.514	0.919	0.456	0.492	0.541	0.402	0.68
IT5	0.687	0.315	0.45	0.267	0.603	0.919	0.523	0.537	0.585	0.462	0.741
CP1	0.46	0.581	0.613	0.56	0.656	0.334	0.825	0.78	0.374	0.597	0.459
CP2	0.563	0.549	0.622	0.465	0.68	0.379	0.885	0.653	0.399	0.65	0.479
CP3	0.599	0.334	0.466	0.271	0.624	0.545	0.75	0.548	0.358	0.489	0.554
OP1	0.501	0.494	0.53	0.516	0.61	0.451	0.665	0.807	0.447	0.573	0.493
OP2	0.523	0.495	0.582	0.461	0.681	0.486	0.696	0.904	0.402	0.659	0.534
OP3	0.512	0.566	0.591	0.489	0.658	0.409	0.693	0.831	0.355	0.642	0.493
FR1	0.561	0.285	0.43	0.328	0.453	0.57	0.388	0.384	0.926	0.408	0.608
FR2	0.621	0.372	0.45	0.361	0.492	0.603	0.422	0.452	0.957	0.43	0.647
FR3	0.606	0.387	0.496	0.403	0.54	0.603	0.474	0.482	0.925	0.493	0.692
SB1	0.56	0.443	0.564	0.486	0.576	0.398	0.59	0.623	0.352	0.827	0.435
SB2	0.515	0.358	0.436	0.407	0.466	0.368	0.527	0.565	0.295	0.833	0.383
SB3	0.528	0.476	0.534	0.44	0.657	0.4	0.606	0.639	0.401	0.861	0.468
SB4	0.547	0.448	0.538	0.471	0.619	0.423	0.622	0.646	0.405	0.88	0.478
SB5	0.406	0.491	0.528	0.515	0.48	0.225	0.513	0.532	0.338	0.826	0.381
SB6	0.576	0.447	0.554	0.407	0.603	0.462	0.602	0.617	0.449	0.861	0.522
SB7	0.639	0.498	0.582	0.467	0.657	0.484	0.686	0.697	0.519	0.805	0.616
TM1	0.689	0.271	0.429	0.211	0.539	0.696	0.458	0.499	0.577	0.457	0.875
TM2	0.733	0.304	0.457	0.287	0.556	0.73	0.54	0.517	0.651	0.455	0.919
TM3	0.709	0.378	0.521	0.318	0.615	0.642	0.601	0.56	0.598	0.517	0.893
TM4	0.661	0.364	0.518	0.26	0.558	0.626	0.506	0.535	0.626	0.573	0.841

Notes: AI, intention to adopt blockchain technology; CO, compatibility; DN, data processing needs; DS, data security; FB, functional benefits; IT, information technology infrastructure; CP, competitive pressure; OP, coercive pressure; FR, financial resources; SB, symbolic benefits; TM, top management.

Table 7. Model validity.

Construct	Path Co.	f^2	R^2	Q^2
TTF→FB	.75***			
ETF→SB	.76***			
FB→AI	.17***	.046	.56(FB)	.297
SB→AI	.19***	.064	.58(SB)	.370
VI→AI	.60***	.668	.73(AI)	.604

Notes: TTF, task-technology fit; FB, functional benefits; ETF, environment-technology fit; SB, symbolic benefits; AI, intention to adopt blockchain technology; VI, Viability.

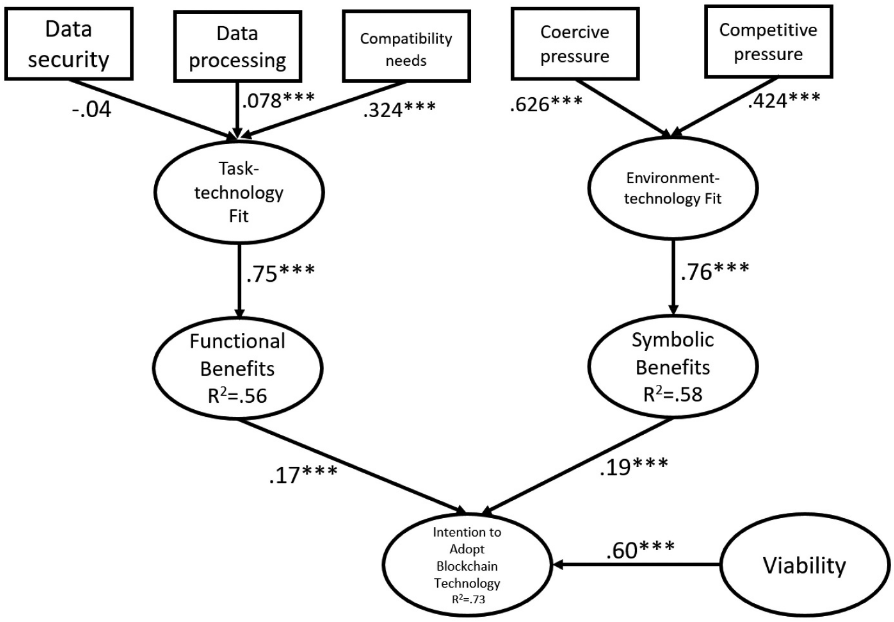

Figure 2. Results of path analysis. *Notes*: *p < .05; **p < .01; ***p < .001.

respondents are less concerned about security since the existing IS already meet their needs of information security. As indicated, all five hypotheses are supported.

To examine the potential problems of collinearity, we employ suggestions from Hair et al. [26] by calculating the value of variance inflation factors (VIF). A VIF of greater than five represents existence of collinearity [26]. We calculated VIF in SPSS 24 which yielded a value 3.76, below the criterion of Hair et al. [26], indicating that collinearity was not an issue.

To formally examine the existence of common method variance (CMV), we used Harman's one-factor test to construct the analysis [56]. All items were loaded in one common factor and the analysis showed that the total variance for a single factor was less than 46.92 percent, suggesting that CMV does not affect the data.

Additional Analysis

To examine whether adoption of blockchain technology in different situations may have different positive or negative impacts, we separate the response into two groups: one group of individuals who work in the finance sector with 113 responses, and the second group comprising respondents in the medical sector with 129 responses.

The results of this extended analysis for individuals in the finance sector show that TTF is positively related to functional benefits. EFT is positively related to symbolic benefits. Functional benefits are positively related to intention to adopt blockchain technology. Symbolic benefits are positively related to intention to adopt blockchain technology. Viability is positively related to the intention to adopt blockchain technology. The results of bootstrapping show the data security→ TTF link is non-significant (t = .428, p = .887). It

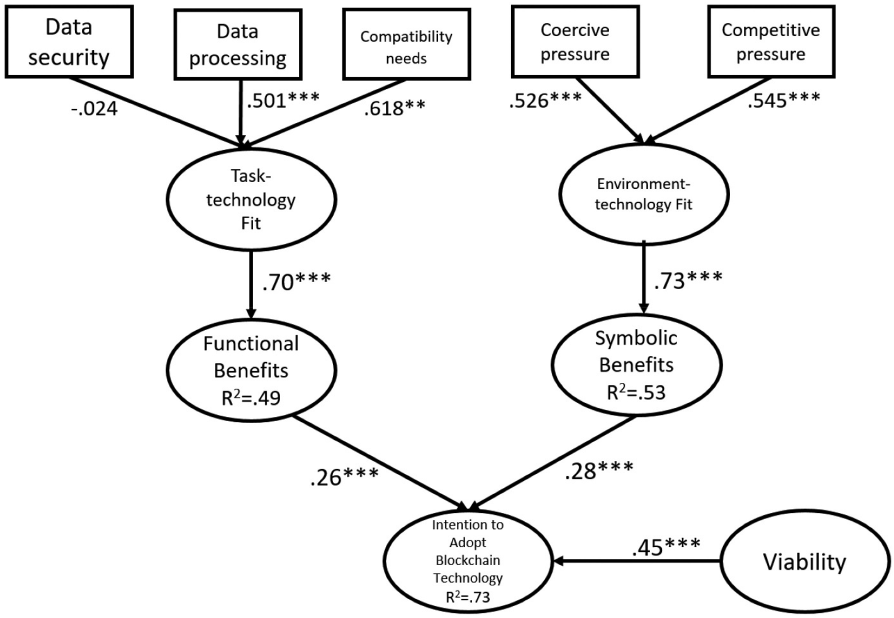

Figure 3. Results from the managers in finance sector. *Notes*: *p < .05; **p < .01; ***p < .001.

is likely that financial sector respondents are concerned primarily about data processing and compatibility, perhaps because their existing security system is good enough and optimized for financial operations. We present our results of financial sector respondents in Figure 3.

For respondents in the medical sector, the results of the analysis show that TTF is positively related to functional benefits. Environment-task fit is positively related to symbolic benefits. Viability is positively related to the intention to adopt blockchain technology. However, functional benefits and symbolic benefits are not positively related to the intention to adopt blockchain technology. The reason may be that in comparison with the finance sector, individuals in medical sector overlook the benefits from blockchain technology and its impact on self-worth and are more attentive to whether data transmission complies with standards of data privacy, immediacy and accuracy. When these key standards can be achieved, they may feel that there is a minimal reason to be concerned. Therefore, we do not find support for H3 and H4. Figure 4 shows the results.

Discussion

Findings and Contributions

Our findings contribute to the literature in several ways. First, we find that TTF is positively related to functional benefits of blockchain technology. This provides a link between the fit with the tasks at hand and how they relate to the benefits that firms are expected to extract. As the ETF is positively related to symbolic benefits, our findings support the notion that managers are also cognizant of how the adoption of technology is viewed as reputation enhancing by internal stakeholders. Moreover, our findings further the idea that managers

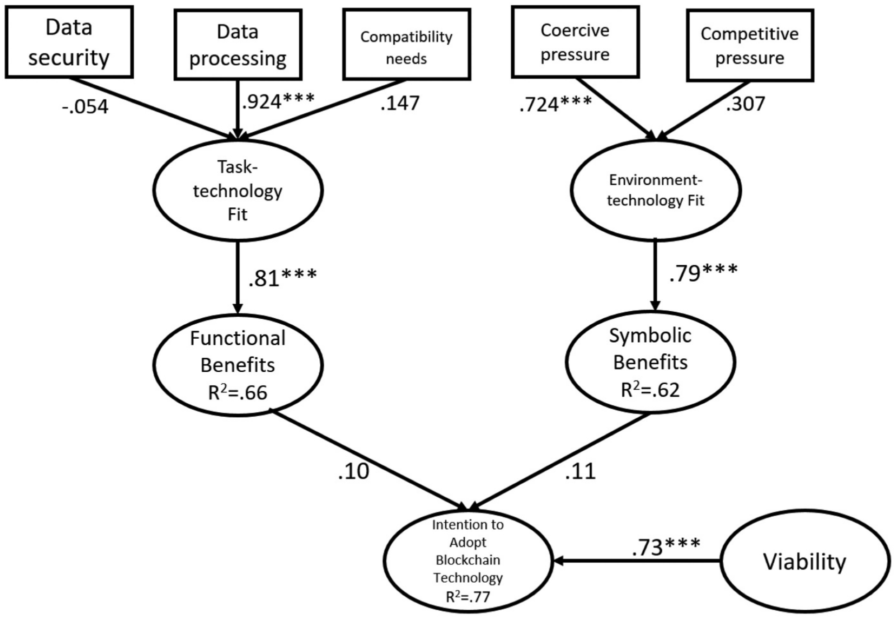

Figure 4. Result from managers in healthcare sector. *Notes*: *p < .05; **p < .01; ***p < .001.

see viability of blockchain technology and are more likely adopt it when it garners functional and symbolic benefits.

To our knowledge, our study is the first attempt to deploy TTF, ETF, and FVM to construct and test a model of intention to adopt blockchain technology. Moreover, our findings further clarify the emergent benefits as functional and symbolic. We also find that viability, measured through organizational factors, is an antecedent to strengthening the intention to adopt blockchain technology. This clarification emphasizes a deeper understanding of how external use of new technology factors (i.e., TTF and ETF) influence adoption to blockchain technology. More importantly, our use of FVM indicates that internal factors in an organization increase the likelihood of blockchain technology adoption.

Theoretical Implications

With our findings previously described, we make several theoretical contributions to the literature. First, the results show that environmental factors can explain intention to adopt blockchain technology. In this study, ETF, measured by competitive and coercive pressures, emerges as one of the sources that facilitates the adoption of IT. The reason that both pressures play an important role is due to interaction between organization and environment. With the influence of the environment, organizations are pushed to adopt advanced technologies in order to compete. For example, when Walmart announced that it was going to use RFID technology, its suppliers, and those who hoped to become suppliers, rushed to adopt and experiment with RFID.[2] Indications are that Walmart suppliers are facing similar pressure to adopt blockchain.[3] While this may appear irrational, it is likely to hasten adoption of blockchain resulting in the network effects that will streamline transactions for Walmart as well as its suppliers.

Second, TTF and ETF can enhance intention to adopt blockchain technology. The result is consistent with previous findings. Lu and Yang [43] found that task, social, and technology characteristics influence intention to use Social Networking Sites (SNS). In our study, blockchain technology represents a tool for improving the quality of transactions. Transactions with security, speed, and efficiency can better help organizations exchange digital information more frequently and conveniently. Therefore, both TTF and ETF are important factors for intention to adopt an IT.

Third, we found that viability leads to intention to adopt blockchain technology. Viability is measured by financial resources, IT infrastructure, and top management support. These dimensions create a new theoretical basis for investigating intention to adopt IT within an organization and open a new path for future research. Such organizational factors are a key in promoting adoption of new IT.

Implications for Blockchain Technology Providers

Our findings contribute new knowledge and important implications for organizations. An understanding of the factors that influence managers' perception also increases the likelihood of blockchain technology adoption among organizations. Specifically, we found that functional benefits are positively related to the intention to adopt blockchain technology. Therefore, blockchain technology providers should emphasize functional utility of blockchain to customers. For example, the functional utility of blockchain technology includes greater transparency, enhanced security, improved traceability, and increased efficiency and speed [30]. By promoting such functional utility, the adoption and use of blockchain technology can increase.

We found that symbolic benefits are positively related to the intention to adopt blockchain technology. This finding could foster the development of strategies to promote advantages of self-worth in using blockchain technology. For example, blockchain technology providers could remind customers that using blockchain technology can enhance social approval, industry leading status, and the reputation of using advanced technology, particularly when their business partners have already adopted blockchain. By promoting extrinsic advantages, the intention to adopt blockchain technology can be enhanced.

Finally, our finding that viability is positively related to the intention to adopt blockchain technology suggests that managers must seek the support of senior management, secure financial resources, and essential equipment. Hence, blockchain technology suppliers could gauge company's current status and the level of support for blockchain technology, and then fill the gap in order to meet the anticipated demands of the business to ensure a successful adoption.

Research Limitations and Future Research Directions

We tested and found support for the relationship between functional and symbolic benefits and intention to adopt blockchain technology, specifically in the financial and medical sectors. However, using blockchain technology involves a bilateral transaction with two or more groups or businesses, sometimes between industry sectors. Therefore, future studies could explore the relationship by investigating social factors such as cooperation and interdependence across industries for adopting blockchain technology.

Competitiveness can be another criterion to test the intention to adopt a new technology. From the perspective of competitive advantage, adopting a new technology can help businesses to gain an advantage over competitors. However, future research may explore whether the decision to adopt a technology is related to company size (large, medium, and small) with varying preference of focus on functional and symbolic benefits.

Our research invited members of online forums to participate in a questionnaire. Despite carefully pilot-testing and improving the questionnaire instrument, potential bias such as data collection, honest responses and validity are inherent survey concerns that also relate to off-line research. Future studies may compare whether adopting conventional off-line research for identifying the critical factors affecting intention to adopt blockchain technology yield similar findings.

Our research explored how managers' perception of functional benefits, symbolic benefits, and viability influence their intention to adopt blockchain technology. The scope of this study did not include how they perceive blockchain security for data management and privacy. Blockchain technology has a specific architecture and components that include various layers, such as data, network, consensus, incentive, contract, and application [77]. In this study, we explored managers' intention to adopt blockchain technology which is targeted to the application layer. We focus mainly on how and why existing organizations adopt blockchain technology. Indeed, blockchain is a revolutionary new technology that can fundamentally change how organizations, industries, and markets function and also generate new business strategies. Future studies may consider how the disruption factors of blockchain (i.e., decentralization) impact new ventures and existing centralized organizations (i.e., banks and other financial businesses).

Conclusion

We integrated concepts from TTF, ETF, and FVM to explain the managers' intention to adopt blockchain technology in organizations. As managers act as gatekeepers of new information technologies, it is important to understand what motivates them to adopt new technologies such as blockchain. We adopted perspectives of functional benefits and symbolic benefits to assess the intention to adopt blockchain technology. Our findings provide evidence that viability and fit, among other symbolic factors such as reputation, enhance the intention to adopt blockchain technology. These findings offer blockchain technology providers valuable insights into how to replace or supplant old processes with new and efficient technologies. Our study will serve as a foundation to incorporate social impacts into TTF, ETF, and FVM to explore intention and attitude to adopting a new technology.

Notes

1. Although successful cases of adopting IT exist, wrongdoing with IT use is also noteworthy. Numerous examples of the negative and fraudulent use of IT are reported such as Silk Road, the DAO, and Quadriga.

2. Sliwa and Brewin (2004) describe how WalMart tested its suppliers' RFID technology readiness https://www.computerworld.com/article/2563877/rfid-tests-wal-mart-suppliers.html.
3. Rosencrance (2018) describes Walmart's effort to seek transparency in food supply chain is pushing its suppliers to adopt blockchain technologies. https://www.computerworld.com/article/2563877/rfid-tests-wal-mart-suppliers.html

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