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Research Article

Extending the Technology Acceptance Model: A New Perspective on the Adoption of Blockchain Technology

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While previous studies have investigated the factors influencing Internet adoption, the findings may not be transferable to explain blockchain technology (BCT) adoption, despite its similarities to the Internet. This study addresses this gap by developing an extended technology acceptance model (TAM) to investigate the factors influencing BCT adoption. The model consists of four key factors, including strategic management and social influence at the firm level, and individual innovation and self-efficacy at the individual level. Data were collected from 384 employees at Taiwan Stock Exchange companies, and structural equation modeling was utilized to test the hypotheses. Results reveal that strategic management and social influence at the firm level have a direct impact on BCT adoption, which is indirectly influenced by perceived usefulness. Subsequently, training and support provided by the firm can enhance individual innovation and self-efficacy, which has direct effects on BCT adoption at the individual level and is partially mediated by perceived ease of use.

1. Introduction

Blockchain technology (BCT) is a distributed ledger technology that enables the secure and decentralized storage and sharing of information through a network of interconnected nodes. It utilizes cryptographic algorithms to verify and record transactions in a secure and tamper-proof manner without the need for a centralized authority [1]. The technology is based on the principles of consensus, transparency, immutability, and decentralization and, thus, has the potential to transform various industries by enabling new business models of trust and collaboration [2]. Practically, firms adopt BCT as a solution to address a range of business challenges, including data security, transparency and trust, efficiency and cost savings, compliance, and regulatory requirements [3]. From an economic perspective, blockchain technology can enable faster and cheaper transactions by eliminating intermediaries in the financial sector [4]. In supply chain management, the use of BCT can also provide greater transparency and accountability, which can lead to more efficient and cost-effective operations. From a technical perspective, BCT enhances security by ensuring the authenticity and integrity of the data stored on the blockchain [5], and it improves privacy by allowing users to conduct transactions anonymously [6].

Nevertheless, BCT has not yet seen widespread adoption, except for a few industry-specific businesses that have a strong focus on financial transactions and information disclosure. The low adoption rate of BCT can be attributed to a lack of awareness and understanding of the technology [7]. Moreover, the perceived return on investment in BCT is often unclear, and there may be resistance to investment due to the perceived risks and uncertainties associated with the technology [8]. The hesitancy to invest in BCT can be further compounded by regulatory uncertainties and concerns about security and privacy. Therefore, this study is aimed at introducing the essential determinants that enable firms to effectively enhance the awareness and understanding of BCT in order to promote the widespread adoption of this disruptive technology.

In the academic context, the theoretical foundation adopted in this study represents an elaboration of the technology acceptance model (TAM), a prevalent conceptual framework employed to explain the phenomenon of information

technology (IT) adoption and usage [9]. Fundamentally, TAM discloses perceived usefulness (PU) and perceived ease of use (PEOU) as two key constructs that have crucial impacts on the intention to use technologies and, in turn, make decisions based on functional, financial, and attitude reasons [10]. The relationship between PU and PEOU is that a user's perception of the ease of use of technology can significantly influence their perception of its usefulness. If a user finds a technology difficult to use, they are less likely to see it as useful, even if it has valuable features. Similarly, if a user finds a technology easy to use, they are more likely to see it as useful, even if it has limited functionality [11].

During the Web 2.0 era, for instance, Internet technology reached a state of maturity, and its applications enabled the expansion of business development through e-commerce, leading to a significant transformation of the previous business ecology. The transformative impact of Internet technology is primarily attributable to its PU and PEOU. Researchers have applied this TAM to identify variables that influence organizational approaches to Internet adoption and implementation, from both individual-level [12] and firm-level perspectives [13].

However, the original assumption that the user's PU of the technology is influenced by PEOU may not be applicable to BCT. One explanation is that the benefits of BCT are often realized through its unique properties rather than its ease of use. Therefore, a user's PU of BCT may be more influenced by their understanding of these properties and how they can benefit from them than their evaluation of its PEOU [14]. The other explanation is that users may be more willing to tolerate a certain level of complexity or difficulty in using BCT if it provides enhanced security and privacy features [15]. Under these circumstances, this study proposes an extension of the TAM to investigate the separate effects of PU and PEOU on the adoption of BCT. Specifically, the study examines PU at the firm level and PEOU at the individual level. In addition, the study contributes to the literature by introducing two primary inputs for the PU construct, namely, strategic management and social influence, and two for PEOU, which are personal innovativeness and self-efficacy.

In essence, this study is primarily aimed at investigating the factors contributing to the enhanced awareness and understanding of BCT within firms, with the overarching goal of promoting its widespread adoption. To achieve this, the research conducts a comprehensive examination, initially focusing on how BCT's unique attributes influence users' PU and their willingness to adopt it. Additionally, it scrutinizes the role of PEOU in shaping users' perceptions of BCT's utility. The study also encompasses an analysis of users' readiness to engage with the complexity of utilizing BCT, especially in contexts offering heightened security and privacy features. To ensure a holistic understanding, the TAM is extended to explore PU at the firm level and PEOU at the individual level. Furthermore, various factors such as strategic management, social influence, personal innovativeness, and self-efficacy are considered, aiming to illuminate their influence on how both firms and individuals perceive BCT.

2. Theoretical Background and Hypotheses

TAM explains usage intention and attitude toward new information technology. Both PU and PEOU are identified as the determinants of intention, which in turn determines the adoption of certain information technologies by potential users. PU explains that an individual believes that technology will enhance job performance, whereas PEOU describes that an individual believes that the usage of that particular technology will be free of effort [9]. Although the decision to adopt new technology is made by owners, employee behavior toward this technology adoption is a key driver in explaining whether or not the new technology implementation succeeds.

At the individual level, employees may improve their job performance and, thus, increase the PU of BCT while a firm undertakes its strategic management, including investing in digital infrastructure to increase competitiveness [16], delivering better services toward the customers in achieving the goals [17], and adopting proactive action while facing innovative technologies [18]. Moreover, studies have recognized the impact of social influence on technology adoption [19]. Given a variety of forms of social influence, implicit expectations may enhance an individual's perceived usefulness of BCT, including conformity and social roles [20]. To successfully implement BCT, it also depends on PEOU, which is highly related to individual innovativeness consisting of user traits [21], user satisfaction [22], and user involvement [23]. Self-efficacy represents an individual's PEOU to use BCT applications in the accomplishment of a task [24], involving social cognitive by considering two forces: an individual's beliefs [25] and the company's support [26]. A conceptual model was developed as shown in Figure 1.

2.1. Strategic Management and PU. As managing strategies helps decision-making and goal development, strategic management can help firms keep pace with evolving technologies and markets and, in turn, gain a competitive advantage. Understanding a firm's conditions and forces helps top management build a strong top-down model of strategic management in which its core competence, including skills and knowledge, is embodied and distributed throughout the firm [27]. As a set of discourses and practices, a corporate strategy that emphasizes core competence can transform managers and employees into subjects who together share and recognize the purpose and reality, rather than managers imposing their plans on employees [28].

Companies across various industries need strategic management to find ways to sustain their competitiveness. Due to environmental contingencies, companies need to monitor environmental changes and modify corporate strategy accordingly. In the Web 2.0 era, for instance, the Internet has dramatically changed the business environment and created more opportunities through electronic commerce for companies across the globe. E-commerce technology is greatly perceived as useful and beneficial to companies and thus significantly affects all industries in terms of business model and strategic management [29]. Unlike ubiquitous Internet-based technology, which is perceived as a relatively

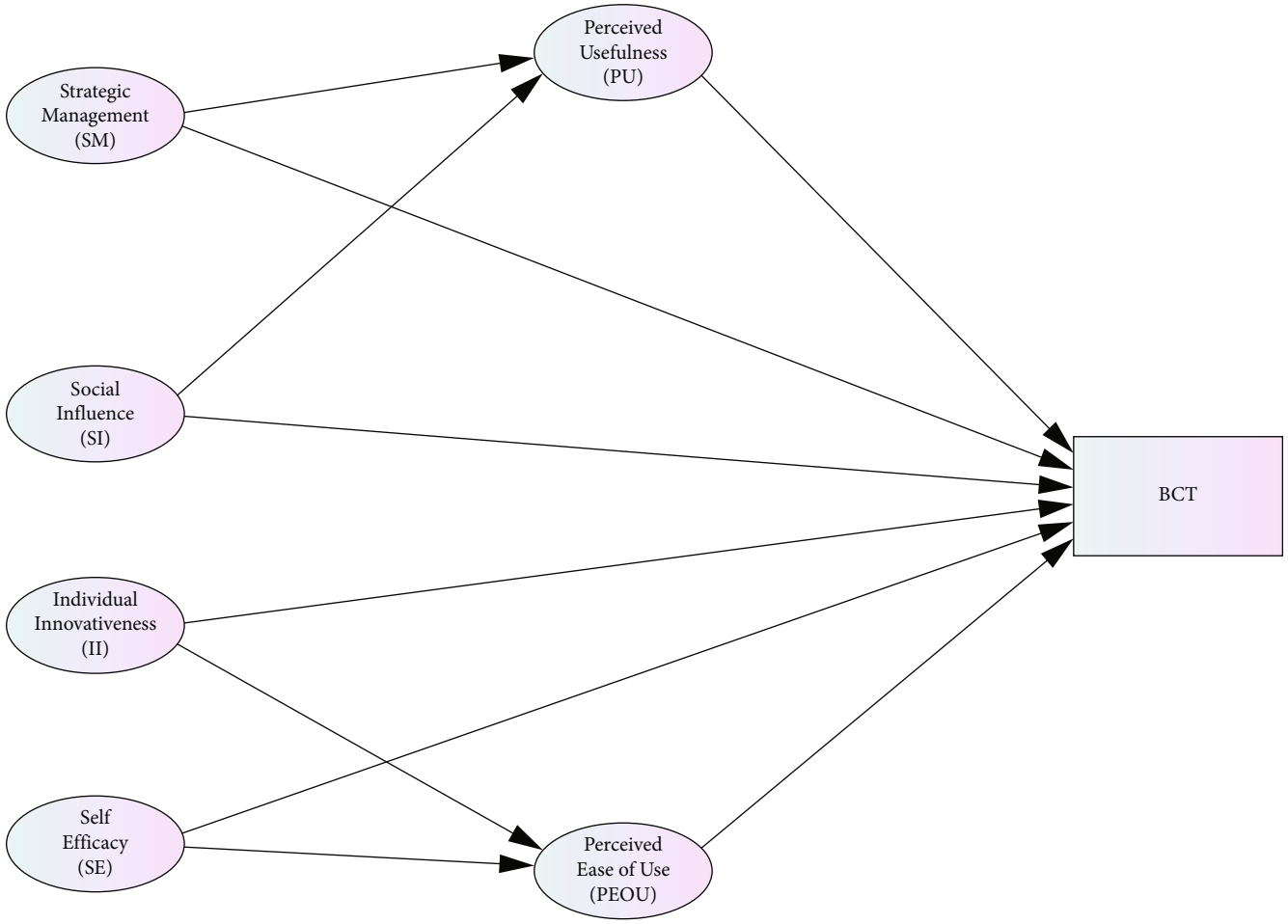

Figure 1: Research model.

low-risk, high-reward strategy, BCT at its current embryonic stage is unclear to many business owners about how to utilize it. From the perspective of the resource-based view (RBV), BCT adoption may become a heterogenous capability at the firm level [30]. Companies possessing this distinctive competence need strategic management to coordinate human power and improve individual capabilities in terms of technical know-how, which generates a huge foundation of competitive advantage [31].

Strategies focusing on human resource management drawn from the RBV may also lead to competitive advantages such as high investment in employee skill and capability development toward specific behaviors [32]. When investment strategies are consistently implemented across employees, a unique climate of greater collective employee attachment to the firm is created [33]. As such, strategic efforts can motivate employees that align with firm resources to effectively support ongoing adaptation, which, in turn, leads to the creation of a competitive advantage [34]. Given the strategic management of human resources in creating competitive advantages at the firm level, the underlying logic of this relationship mainly depends on employee behavior as a mediating mechanism [35].

Unlike the exponential growth of the Internet, the emergence of BCT is currently attracted to a handful of business sectors, mainly in the banking and finance industries. It is intended to propose three aspects to explore the relationship between PU and BCT through strategic management. To begin with, companies may adopt proactive action while facing innovative technologies [18]. Built upon the extension of the technologies presented on the Internet and to mitigate the security risk arising from the Web 2.0 technologies [36], BCT may bring positive opportunities for various business sectors even though the immaturity of Web 3.0 at the current embryonic stage may give rise to complications in the future [37]. Business owners need to prepare in advance for the changes accompanying BCT before this cutting-edge technology is fully realized in order to capitalize on trends, seize new opportunities, and satisfy customer needs [38].

Secondly, IT infrastructure is considered the foundation for long-term business success. Several studies showed that a firm with a strategic orientation to IT is more likely to have higher performance, and thus, a strategy of investment in a dynamic and flexible IT infrastructure helps firms achieve strategic objectives [16]. Finally, employees could perceive a new technology to be beneficial in a certain way or to improve job performance so that they consider it worth spending the time to learn, whereas in turn delivering better services to the customers [17]. Once the company owners recognize the benefits of BCT and decide to adopt it,

strategies such as effective collaborative learning sessions in the use of this technology should be implemented. Strategic management incorporating these three aspects together may create an internal climate and express a firm's strategy that draws employee involvement and collaboration in influencing work processes, which in turn enhances PU among employees. A 5-item measure of strategic management affecting BCT through PU was designed based on the literature review of three aspects [39]. Therefore, this study proposed the hypotheses as follows:

H1a: strategic management has a direct effect on BCT adoption.

H1b: PU has a mediating effect on the relationship between strategic management and BCT adoption.

2.2. Social Influence and PU. Social influence plays a critical role in influencing information technology adoption [19]. It greatly determines technology acceptance and usage through the construct of subjective norms [40, 41]. As an individual's thoughts and behaviors can be influenced by the power of the social situation, companies can capitalize on the drivers of different social influences while managing strategies. For instance, conformity occurs when employees change their behaviors in order to feel good or to be accepted [20]. In this sense, business leaders may develop organizational strategy by building a positive corporate culture with a strong collective ability of employees to share knowledge and experience so that the increase in overall rates of conformity will lead to the adoption of technology for collaboration.

The way that social influence involves social roles enhances employees' perception of usefulness within the context of using technology [20]. On one hand, interpersonal interaction generates perceived pressure through messages or signals for individuals to act on certain behaviors [42]. Social cognitive theory [43] explains that environmental influences (e.g., group pressures) and personal factors (e.g., personality) reciprocally determine behavior. Individuals regard cooperation as a collective agency in which shared belief in collective power leads to desired outcomes [44]. As going with the flow is a better option, an employee may perceive the usefulness of technology adoption when the information obtained from a reference group shows acceptance of BCT usage [45]. The reference group could be the top management's support for technology use, the encouragement of use by others in the reference group, or the actual use by others in the reference group [24]. In this sense, an effective way of increasing group pressure is to form a positive corporate culture and a group of people who share a profession.

On the other hand, social exchange theory illustrates that interpersonal exchanges significantly affect the work effectiveness between members largely through the reciprocal relationship [46]. The process of reciprocal exchange involves reciprocity of behavior and reciprocity of emotion [47] and a series of mutually beneficial relationships such as work experience sharing, work communication, and mutual assistance for work goals [48]. When top management regards a new technology as a useful tool to sustain competitive advantages, the affective bonds individuals form with leaders and coworkers have significant effects on the perceived usefulness of technology adoption.

The synthesis of these social roles suggests that social influence is generally enabled and facilitated by the surrounding environment and people. Stibe et al. [49] further studied key factors to assess social influence in human-technology interaction, and the main conclusion was that both social recognition and social competition together will lead to social cooperation. The former describes that an individual receives an acknowledgment for a positive performance after competing or cooperating with others [50], while the latter explains that people compete when they strive to achieve a goal that is scarce or that others are pursuing as well [51]. Both intrinsic factors may facilitate personal learning if a company creates a competitive environment where employees can compare their performance against others.

The current challenge associated with BCT adoption across business sections is a lack of understanding of how it works. However, once a firm perceives the usefulness of BCT and decides to adopt it, the effects of social influence processes in the firm play a crucial role in employees' BCT perceptions. This study combines the concatenation effects of both corporate culture and personal attributes involving competition, recognition, and cooperation to represent the social influence construct. Three measured items of social influence affecting BCT through PU were adopted from the Stibe et al. [49] study. Based on the context, this study proposed the hypotheses as follows:

H2a: social influence has a direct effect on BCT adoption.

H2b: PU has a mediating effect on the relationship between social influence and BCT adoption.

2.3. Individual Innovativeness and PEOU. Innovativeness is commonly divided into firm level and individual level, as it influences innovative behavior at different levels. Subramanian [52] describes innovativeness as an enduring trait that a firm consistently displays in its innovative behavior over time, while Rogers [53] explains innovativeness as an individual's perception regarding innovation that is highly related to personal characteristics such as being open to new technology. In the literature on innovativeness, a conceptual differentiation between innovativeness and innovation has been recognized [54]. Innovativeness is the antecedent to innovation, indicating that a firm should regard innovativeness as an input of strategic orientation and innovation as an output of competitive advantages [55, 56]. In this sense, innovation is an end, but innovativeness is rather a means to an end [57]. From a behavioral perspective, innovativeness at the firm level is an essential commitment and willingness along with technological capabilities that initiate innovation activity [58], whereas innovativeness at the individual level is a critical work behavior of an employee's engagement to be innovative [59]. As BCT has been adopted by some business sectors for their competitive advantages, a key determinant of driving a successful BCT implementation is the degree of this technology's usage, which can be predicted by individual innovativeness [60].

In the context of individual innovativeness, Rogers [53] developed the diffusion of innovation model to address the fundamental factors that significantly influence an individual's tendency toward innovation adoption. The logic within the model emphasizes the degree to which an individual adopts innovation relatively earlier than other members of an organization [53]. The concept of individual innovativeness largely depends on different levels of innovative perception that are intrinsically inclined to individual innovative behavior [61], which is affected by differences in personality characteristics [62, 63] and psychological factors [64].

Several personal characteristics have been identified as contributors to individual innovativeness, including not being afraid of taking risks [65], obtaining more advanced technical knowledge than peers [59], trying out new experiences [63], being open to changes [62], and acting respectfully and confidently [66]. Meanwhile, the role of goal orientation has been identified as the key psychological factor in shaping individual innovativeness that critically influences an individual's engagement in technology usage [67]. Researchers categorized goal orientation into three types, including mastery, performance approach, and performance avoidance [68], explaining that individuals tend to engage in a task in order to sharpen skills, improve capacities, show better performance, surpass their peers, and avoid appearing incompetent [69]. Both positive personal traits and powerful goal-setting interact and cooperate in shaping high individual innovativeness, which in turn may lead to a positive attitude and confidence toward BCT adoption.

Individual innovativeness has a direct effect on PEOU and, in turn, influences technology adoption [21]. To enhance an individual's PEOU, researchers typically focus individual innovativeness on the degree of understanding the application complexity of a new technology [9] or training [70]. Nevertheless, Venkatesh [26] proposed that some individual and situational variables should be taken into consideration, such as anchors (referring to general beliefs about computers and computer usage) and adjustments (referring to an individual's past experiences with a target technology). According to Venkatesh [26], the initial anchor of the PEOU of a new system in the early stages of user experience is based on an individual's prior general beliefs and distinct experiences with computers or software. As the experiences increase, an individual's system of PEOU will be adjusted to reflect the unique properties of interaction with the system and the system environment. Adjustments based on direct experience are important for shaping PEOU over time [71].

Web 3.0 is not a new system but an extension of the technologies that existed in Web 2.0. The BCT behind Web 3.0 is developed on the basis of existing computer and Internet technologies, and companies running with Web 2.0 may likely adopt BCT in order to keep their services relevant [72]. In this regard, the PEOU of BCT will be adjusted to reflect the unique properties of interaction with BCT as well as the increase of the existing Web capabilities and knowledge. This study designed three questionnaire items on individual innovativeness affecting BCT through PEOU obtained from studies by Venkatesh [26] and Saville and Foster [73]. Based on the context, this study proposed the hypotheses as follows:

H3a: individual innovativeness has a direct effect on BCT adoption.

H3b: PEOU has a mediating effect on the relationship between individual innovativeness and BCT adoption.

2.4. Self-Efficacy and PEOU. Self-efficacy is the perception that one has the capability to perform a particular behavior [74]. This construct is deemed the key determinant that influences an individual's decision to use information technology [75]. Individuals would be willing to use new technologies such as computers if positive benefits could be obtained by using them [76]. In this regard, computer self-efficacy describes the capability an individual has to use computers in the accomplishment of a task, such as understanding how to use a software package for data analysis rather than just simply booting up a computer [24]. In the Web 2.0 era, Internet self-efficacy critically shapes one's perception and attitude toward the adoption of online-based technologies [77]. A higher level of Internet self-efficacy may result in a greater level of performance in implementing online technologies [78]. The same notion will be applicable to Web 3.0, as technology self-efficacy explains a user's self-confidence in adopting BCT to carry out relevant tasks in order to attain designated types of performance.

For technology self-efficacy, potential users will select a technology mainly based on its PEOU, its quality, its access, and the associated cost of access [79]. The PEOU becomes the major concern for employees as the company takes care of the rest while deciding to adopt new technologies. Davis [9] describes PEOU as the degree to which an individual perceives the convenience of the required physical and mental efforts to learn a technology. Researchers have provided evidence that an individual's beliefs about the effort required to use technology may influence PEOU [80]. Eventually, both cognitive characteristics and personality traits intertwined with intrinsic motivation to form an individual's beliefs [25, 70].

Among the reflective indicators, some researchers pointed out that technology self-efficacy plays a decisive role in shaping an individual's beliefs toward the PEOU of new technologies [74], whereas others concluded that self-efficacy directly influences PEOU [24]. In order to strengthen technology self-efficacy and, thus, improve the PEOU of a specific technology or system, a firm's support, such as training intervention, is essential to enhance user perceptions and beliefs about the new technology [26]. For Web 3.0, companies may pave the path for acceptance of BCT by providing employees with BCT-specific training programs that focus on increasing BCT awareness, reducing BCT anxiety, and enhancing BCT self-efficacy. More importantly, an effective training program to elevate technology self-efficacy should be delivered through technologically sophisticated channels such as virtual reality rather than via textbooks or comic strips [73].

Self-efficacy affecting BCT through PEOU was measured by three items drawn from Compeau and Higgins [24], reflecting how self-efficacy influences technology usage

through outcome expectations, affect (or interest), and anxiety. In accordance with the logic described above, this study proposed the hypotheses as follows:

H4a: self-efficacy has a direct effect on BCT adoption.

H4b: PEOU has a mediating effect on the relationship between self-efficacy and BCT adoption.

Finally, a shortened version of valid measurement scales for predicting user acceptance of technology developed by Davis [9] was adopted, including four items for variable PU and four items for PEOU. The summary of all theoretical variables and hypotheses is shown in Tables 1 and 2.

3. Research Method

To assess the dependent variable of BCT adoption, this study followed the recommendations of some surveys published by leading consulting companies such as IBM and Gartner, which provide an overall understanding of the current status of BCT applications across main sectors, including stablecoins, supply chain management, machine-to-machine payments, identity protection, decentralized finance, property transfers, private records, intellectual property, financial reporting, or media and advertising. A company is regarded as adopting BCT if it uses BCT in any one of the above domains. Therefore, the dependent variable is binary (1 indicates that the firm adopts BCT, and 0 indicates otherwise).

In addition, constructs in the study represent the theoretical concepts being investigated. To measure these constructs, the study employed a structured questionnaire containing four demographic questions (i.e., gender, age, BCT adoption, and company age) and six constructs with a total of twenty measured items. Each measured item used a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The study employed a stratified random sampling technique by dividing the companies listed on the Taiwan Stock Exchange (TWSE) into subgroups based on industry affiliation. This approach helps account for the diverse characteristics and behaviors exhibited by companies across various industries. It ensures that the sample includes a proportional representation of companies from each industry sector, preventing any particular sector from being over or underrepresented in the analysis.

The questionnaire was distributed in May 2022 via email to employees working at the companies listed on the TWSE. The sample size was collected until the minimum requirement of 384 was met [81]. According to their recommendations, a minimum sample size of 384 is adequate for a population of the size considered in this study. This sample size should provide sufficient statistical power to make meaningful inferences about the population. The outcome of demographic characteristics is shown in Table 3.

The data is analyzed using structural equation modeling (SEM), encompassing both measurement and structural models. SEM serves as the analytical framework to comprehensively investigate relationships among critical constructs influencing the adoption of BCT within firms. SEM is chosen for its capacity to examine complex relationships among latent constructs. Key assumptions, including linearity, multivariate normality, multicollinearity, and endogeneity, are rigorously assessed for model validity [82].

The SEM framework employs maximum likelihood estimation (MLE) to estimate parameters, known for providing reliable parameter estimates. Model fit is evaluated using various indices, including the chi-square statistic, root mean square error of approximation (RMSEA), goodness of fit index (GFI), and comparative fit index (CFI), to gauge alignment with observed data. Sensitivity analyses, such as bootstrapping, assess result robustness. Transparency, rigorous testing, and model refinement enhance research credibility in line with empirical research best practices [83].

Rigorous validation procedures were applied to ensure the reliability and validity of the measures employed in the study. In evaluating the measurement model, reliability was assessed through multiple criteria, including adequacy (indicated by KMO − MSA > 0.5 and Bartlett's test), composite reliability (CR >0.7), which measures the consistency of responses within constructs, and Cronbach's alpha (Cronbach's $\alpha > 0.7$), evaluating the internal consistency of items. Construct validity was ascertained by calculating the average variance extracted (AVE > 0.5), signifying the extent to which a construct captures variance relative to measurement error [84].

In the assessment of the structural model, the evaluation included model fit, considering parameters such as chi-square/df < 3 and a p value < 0.001, and fit indices, including RMSEA < 0.08, GFI > 0.95, and CFI > 0.9, following Hayes' recommendations [85]. Additionally, a comprehensive path analysis was conducted to evaluate both the direct and indirect effects of each factor on BCT adoption, leveraging the capabilities of SPSS AMOS.

4. Results

For the measurement model, the values of KMO-MSA (0.817) and Bartlett's test ($p < 0.000$) indicate that the factor analysis is useful. Table 4 shows that the factor loading of all the questionnaire items is higher than 0.6 (0.682-0.912). Cronbach's alpha of each research variable is higher than 0.7 (0.786-0.919). The paper appropriately concludes that all of the questionnaire items are satisfactory in terms of internal consistency and that their factors are appropriate to be used for further analysis. In addition, the AVEs of the variables range from 0.556 to 0.756, and the values of the CRs range from 0.789 to 0.919. Both indices are above the recommended value, respectively. The model has no discriminant validity problem because the cross-correlations among the constructs are all below 0.85. The result concludes that this measurement model is acceptable.

In structural model evaluation, the chi-square/df value of 2.387 is significant at the 0.001 level (p value = 0.000), meaning the model fits the data acceptably. Model fit indices are fairly satisfactory (RMSEA = 0.059; GFI = 0.911; CFI = 0.944). Once the model fits well and is theoretically consistent, the interpretation of the parameter estimates and individual tests of significance for each parameter estimate are shown with a path diagram in Figure 2.

Table 1: Summary of theoretical variables.

Variable	Description	Source
Blockchain technology (BCT)	Firms' decisions to integrate BCT into their processes, impacting their competitive advantage	Jin [60]
Perceived usefulness (PU)	The belief that using technology will enhance job performance, a key factor influencing technology adoption	Davis [9]
Perceived ease of use (PEOU)	The perception that technology usage requires minimal effort, impacting attitudes toward adoption	Davis [9]
Strategic management (SM)	The creation and execution of strategies to achieve a competitive edge, influencing technology adoption	Levy et al. [27]
Social influence (SI)	The role of conformity and social roles in shaping technology perceptions and acceptance	Heinzen and Goodfriend [20]
Individual innovativeness (II)	The willingness and ability of individuals to engage with new technology	Rogers [53]
Self-efficacy (SE)	The belief in one's capability to perform specific technology-related tasks	Compeau and Higgins [24]

Source: developed by the author.

Table 2: Summary of hypotheses.

Hypotheses	Description
Related to strategic management (H1)	H1a: strategic management has a direct effect on BCT adoption H1b: PU has a mediating effect on the relationship between strategic management and BCT adoption.
Related to social influence (H2)	H2a: social influence has a direct effect on BCT adoption. H2b: PU has a mediating effect on the relationship between social influence and BCT adoption.
Related to individual innovativeness (H3)	H3a: individual innovativeness has a direct effect on BCT adoption. H3b: PEOU has a mediating effect on the relationship between individual innovativeness and BCT adoption.
Related to self-efficacy (H4)	H4a: self-efficacy has a direct effect on BCT adoption. H4b: PEOU has a mediating effect on the relationship between self-efficacy and BCT adoption.

Source: developed by the author.

Table 3: Demographic characteristics of the sample.

		Count	Column N %
Gender	Male	200	52.1%
	Female	184	47.9%
Age	30 and below	77	20.1%
	31-35	74	19.3%
	36-40	77	20.1%
	41-45	76	19.8%
	46 and above	80	20.8%
BCT adoption	No	312	81.3%
	Yes	72	18.8%
Company age	0-3 years	107	27.9%
	3-5 years	87	22.7%
	5-10 years	90	23.4%
	Over 10 years	100	26.0%

Source: developed by the author.

Table 4: Reliability and validity for each variable.

Variable	Factor loading	AVE	CR	Cronbach's α
SM	0.803~0.854	0.695	0.919	0.919
SI	0.708~0.809	0.556	0.789	0.786
II	0.807~0.865	0.687	0.868	0.869
SE	0.763~0.844	0.657	0.852	0.846
PU	0.682~0.863	0.632	0.836	0.833
PEOU	0.825~0.912	0.756	0.903	0.904

Source: developed by the author.

Both direct and indirect impacts on BCT adoption are shown in Table 5. SM ($\beta = 0.124$, p value $= 0.034$), SI ($\beta = 0.102$, p value $= 0.050$), II ($\beta = 0.259$, p value $= 0.001$), and SE ($\beta = 0.112$, p value $= 0.008$) have direct influences on the BCT Adoption. The hypotheses of H1a-H4a are supported. In addition, the partial relationships of these four factors on BCT adoption show that the value of each factor falls between lower and upper bounds, as 0 falls outside of the bound at 95% confidence intervals, indicating the indirect effects of both PU and PEOU are significant. The outcomes reveal that the mediated effects of the four variables on BCT adoption exist, respectively. The hypotheses of H1b-H4b are also supported.

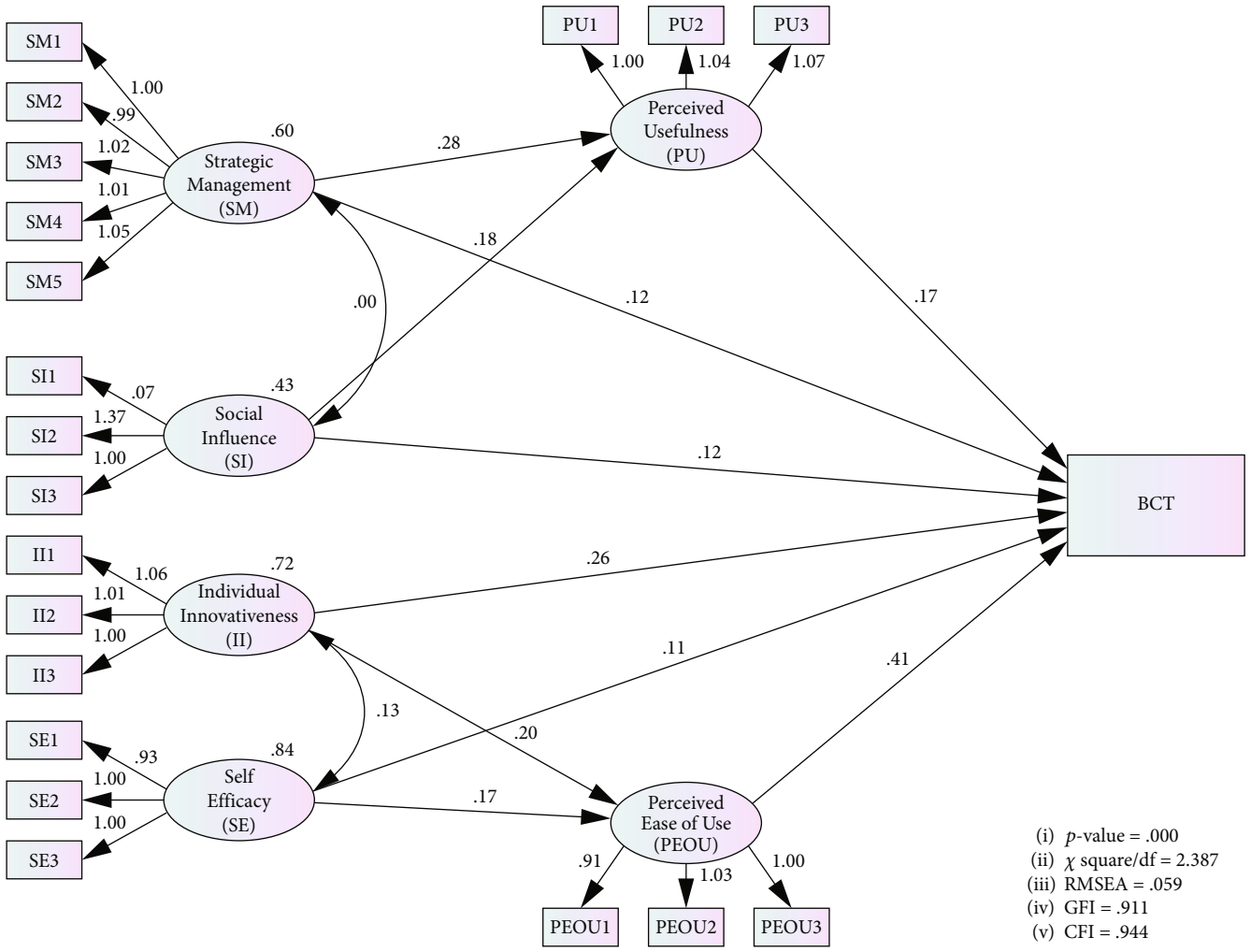

Figure 2: Results of the research model. Source: developed by the author.

Table 5: Direct effects of four key drivers (SM, SI, II, and SE) and indirect effects of two main constructs (PU and PEOU) of TAM on BCT.

IV➔DV M➔IV➔DV	Hypothesis	β	p value	Percentile 95% CI	
				Lower	Upper
SM➔BCT	Direct effect H1a	0.124	0.034	0.014	0.259
PU➔SM➔BCT	Indirect effect H1b	0.048	0.035	0.004	0.114
SI➔BCT	Direct effect H2a	0.102	0.050	0.009	0.286
PU➔SI➔BCT	Indirect effect H2b	0.030	0.028	0.002	0.095
II➔BCT	Direct effect H3a	0.259	0.001	0.122	0.387
PEOU➔II➔BCT	Indirect effect H3b	0.084	0.004	0.026	0.150
SE➔BCT	Direct effect H4a	0.112	0.008	0.032	0.199
PEOU➔SE➔BCT	Indirect effect H4b	0.069	0.002	0.023	0.125

Note: bootstrap 2000 times; M: mediator; IV: independent variable; DV: dependent variable. Source: developed by the author.

5. Discussion and Implication

This study has extended the theory of TAM as the framework in an attempt to explore key drivers that influence a firm to adopt BCT. Despite the conventional reviews that support PU and PEOU as significant mediating factors, two novel paths for the expansion of the TAM are discussed in this paper.

Firstly, the possibility of incorporating PU and PEOU into a dual-process model of firm-individual relationships is analyzed. Previous findings have concluded that users' attitudes toward the adoption of new information technology

are mainly driven by both PU and PEOU [86], and some researchers further assumed that PEOU significantly influences PU [87]. Likewise, this study used the TAM framework, including PU and PEOU categories, as the major reason for adoption in BCT. Nevertheless, different from Web 2.0 technologies that are dramatically adopted by users due largely to the high level of PU and value through PEOU in various domains, Web 3.0 development is currently in its early stages, and BCT applications are too complicated to understand for most people. As a low level of awareness and the PU category are the main obstacles to accepting BCT, the PEOU category is far less likely to be considered. Sectors such as finance and banking, which leverage BCT, demonstrate an initial acknowledgment of the PU. Companies that hope to implement BCT successfully then need to develop strategies to convince their employees to accept this new technology while PEOU is unlikely to be enhanced due to its complexity unless they receive training. Therefore, this study proposes that although PU and PEOU are intrinsically intertwined in TAM, they need to be analyzed separately when it comes to Web 3.0. In other words, from the firm-level perspective, PU is the central reason for adoption in BCT because it helps transform business and enables the firm to maintain its competitive advantage.

From the individual-level perspective, PEOU becomes the indirect driving factor to explain that employees would rather cooperate with the company to adopt BCT than do it because of PU. In the digital era, technology adoption is a strategy for many companies to achieve a competitive advantage in the marketplace. The success of technology implementation highly depends on employees' acceptance. However, BCT is complex and challenging for employees to learn unless it is beneficial for themselves or something they are instructed to do. In order to be able to implement BCT successfully, the company needs to increase the willingness of employees to learn it.

Secondly, the extension of the TAM includes the findings of key drivers that influence BCT adoption through PU and PEOU, respectively. Given that PU is considered a significant mediating variable from a company's standpoint in this study, the findings show that strategic management and social influence are empirically identified as two key factors to assess the impact on BCT adoption through PU. For strategic management, when realizing that BCT can make more competitive and profitable, a company may take action ahead of time even if the current stage of BCT development is in its early stages and full of risks. Strategic management for the adoption of BCT includes support and investment in BCT-related equipment internally while leveraging the company's existing resources and creating first-mover advantages through BCT externally.

In terms of social influence, it can be exerted by a firm since it operates through the behavior and actions of surrounding people. This study utilizes both social exchange theory (SET) and organizational citizenship behavior (OCB) to highlight the significance of creating a supportive and encouraging workplace culture that fosters cooperation and positive interactions among employees. SET suggests that firms should actively support and effectively communicate with employees in order to create a strong commitment, and in return, the employees are more likely to advocate for their companies [88]. Likewise, OCB posits that employees value the organization's supportive behavior and thus feel obligated to engage in this discretionary relationship [89]. In this context, business leaders need to shape an innovation culture by creating a work climate in which top management communicates with and supports the conduct of the employees when using a new technology system [11]. Once the commitment is established, it will facilitate interactions among employees. Consequently, employees may enact like advocacy to express their support for the company [90]. At the firm level, companies have more success when the advocacy process is taking place, and the specific dimension of social influence is the key driver of the PU belief in technology adoption [91].

Another mediating variable, PEOU, in the TAM, is taken from an individual's standpoint, where individual innovation and self-efficacy are the two influential factors that affect BCT adoption through PEOU. For individual innovation, this study supports the previous findings that personality characteristics and psychological factors are indeed the antecedents of technology adoption [62–64]. Additionally, the need for the company to establish a climate for innovation along with positive work-group relations is substantial to influence individual innovation in the workplace [92], and organizational culture has a significant influence on innovativeness [62, 67]. The measured items of individual innovation in this study are designed on the basis of these contexts, and therefore, the result may contribute to the power of the individual-level factor to predict technology adoption through PEOU.

Self-efficacy refers to an individual's perceptions of the ability to use technology in the accomplishment of a task [24]. At the individual level, adopting technology is primarily an individual decision [65, 75]. Some studies found that training self-efficacy is related to how individuals are motivated to learn new technology and the acquisition of skills [93], while others focused on technology self-efficacy, which affects an individual's confidence to utilize specific technologies after effective training programs are conducted [73]. This study combines both types of self-efficacy together to represent self-efficacy, and the analysis shows that self-efficacy has a significant impact on BCT adoption through PEOU ($\beta = 0.112$, p value $= 0.008$). The findings suggest that business leaders need to hire employees with a strong sense of BCT self-efficacy, along with strategies such as effective BCT training options that the employees can appreciate and benefit from. This study further suggests that companies could work to enhance employees' awareness of BCT and the consequences of BCT adoption on performance because they feel more comfortable contributing when they can anticipate how their performance will be judged.

These findings have profound implications for both researchers and practitioners. Firstly, this study expands upon the foundational TAM by investigating the clear distinctions of BCT adoption within the Web 3.0 paradigm. The unique characteristics between PU and PEOU in this context highlight their respective roles. Particularly, PU

emerges as the primary driving force from a corporate perspective, underscoring its pivotal role in influencing BCT adoption decisions at the firm level. Conversely, PEOU assumes subtle significance at the individual level, signifying its critical impact on shaping employees' attitudes toward BCT adoption.

Furthermore, companies considering the integration of BCT should prioritize specific factors, including strategic management, social influence, individual innovation, and self-efficacy. Recognizing both the direct and indirect influences of these factors on BCT adoption decisions is essential. Especially, strategic management takes the spotlight as a pivotal driver, emphasizing the critical role of businesses that exhibit a proactive and strategic stance toward BCT adoption, even during its early phases. This suggests that early strategic adopters can gain a competitive advantage in the BCT domain.

Additionally, fostering a culture of innovation and strengthening employees' self-efficacy play crucial roles in improving PEOU. These approaches can positively influence individual attitudes toward BCT adoption. This highlights the significance of investing in comprehensive employee training programs and nurturing an innovative workplace culture, ultimately facilitating a more seamless BCT adoption process.

Overall, the results support the extension of TAM in evaluating BCT adoption at work. Respondents regarding BCT report that business effectiveness is more decisive than individual interest and desire to use it. As expected, both strategic management and social influence can be bolstered for the firms to elevate the concept of PU, which significantly influences business owners' attitudes toward BCT. Subsequently, support activities provided by the firms to promote individual innovation along with self-efficacy may improve PEOU to form more positive attitudes toward BCT use.

6. Limitation

From a methodological perspective, the limitations of this paper are twofold. Firstly, many small and medium-sized enterprises (SMEs) without getting listed on the stock exchange in Taiwan actually obtain benefits from implementing the BCT in some industries, such as agriculture and food supply. The sample size could be larger by taking those SMEs into consideration. Meanwhile, as the government of Taiwan, a country ranked 7th in technology infrastructure subindices in the IMD World Competitiveness Report 2022, largely provides support to facilitate the adoption of BCT, little did emerging economies consider a national blockchain strategy [94]. Apparently, national capacity influences the development of BCT in different ways in most countries. Future research may expand the data dimension in developing countries and lead to more generalizable outcomes. Secondly, due to its complexity and infancy, BCT is currently adopted only by a few specific industries. This may produce a restriction of range on the selection of the independent variables. As the BCT matures, its applications are expected to be utilized by more business sectors. Future research that investigates the impact Web 3.0 may have on broad-based business drivers that are applicable to most industries and companies but not on industry-specific business drivers. A longitudinal study may explore more vital variables and thus enrich the findings.

From a theoretical perspective, TAM has been a valuable framework for understanding technology adoption for several decades. However, it does have limitations, especially when applied to innovative technologies like BCT in the context of Web 3.0. The proposed extensions to TAM in this study are aimed at addressing some of these limitations but may still fall short of fully capturing the complexity and dynamism of this technology in certain aspects.

Firstly, the primary limitation of TAM is its simplicity. It primarily focuses on two key variables, PU and PEOU. When applied to BCT, which is inherently complex and requires a deep understanding, TAM may oversimplify the decision-making process. The proposed separation of PU and PEOU in the context of BCT acknowledges their distinct roles but may not fully capture the intricacies of assessing this technology's utility and usability. Moreover, TAM assumes a relatively stable technological environment. In reality, however, the technology landscape, especially in the realm of BCT, is highly dynamic, with continuous advancements and evolving use cases. This inconsistency presents a challenge in applying TAM to assess BCT adoption because the model may not fully address the dynamic and evolving nature of technology in this domain.

Additionally, TAM predominantly focuses on individual perceptions and behaviors. While this aligns with the individual-level adoption of technology, BCT adoption often involves organizational decisions. This study introduces a distinction between the firm-level and individual-level perspectives, emphasizing the central role of PU for organizations and PEOU for individuals. However, the interplay between these perspectives remains complex and might require a more nuanced model. Similarly, TAM assumes that the same set of factors applies across different cultures and contexts. The proposed extensions acknowledge the significance of factors like social influence and organizational culture. Still, there might be nuances and cultural variations in how these factors operate, which the extended model may not fully encompass.

Finally, TAM tends to overlook external factors that can influence technology adoption, such as regulatory environments, market dynamics, and competitive pressures. While the proposed extensions encompass strategic management, a more comprehensive model would need to integrate these external factors to provide a holistic view of BCT adoption.

7. Conclusion

This study extends the TAM model and sheds some light on key variables that influence BCT adoption. In the traditional TAM model, PEOU will significantly influence PU because the easier a technology is to use, the more useful it can be. However, there could be a technology that is useful but difficult to use at some point. Just because it is difficult to

operate this technology does not mean it is impossible to learn to use it. BCT is more likely in this circumstance. In this regard, different from the conventional TAM model that considers the cause-and-effect relationship between PU and PEOU, this study proposes that in the era of Web 3.0, companies should determine the PU of BCT in the first place and then improve PEOU for their employees by providing necessary training programs due to its complexity. In a nutshell, PU in the extension of the TAM model is shaped at the firm level, while PEOU is considered at the individual level.

In the meantime, this study proposes four key variables that help firms implement BCT successfully. At the firm level, good strategic management (i.e., variable SM) supports BCT advocacy internally as well as leverages the existing resources to create first-mover advantages through BCT externally. Social influence (i.e., variable SI) is deemed a major determinant of BCT usefulness, which can take place through a strong innovation culture to communicate with and support the behavior of the employees when using BCT. At the individual level, employees with different psychological and personality traits toward technology largely determine their perception of the use of BCT. Business leaders may create a positive climate for innovation and improve intergroup relations to influence individual innovation (i.e., variable II) in the workplace. As skills required for BCT are rapidly evolving and new types of roles are being introduced across different types of markets, companies need to upskill and reskill employees. Employees high in self-efficacy (i.e., variable SE) may react with higher confidence about learning BCT and demonstrate more favorable outcomes after being trained. The findings add to the current innovation research by showing that BCT adoption may result in different profit impacts on a much more specific group of businesses than all industries. While the attributes of BCT are not currently deemed a feasible and optimal tool for companies to reinforce competitive strategies, this cutting-edge technology yields as much influence as the Internet may in the near future. Practically, the outcomes provide companies with solid information to evaluate their current situation while facing the early stages of the Web 3.0 era.

Data Availability

The data that support the findings of this study are available from the corresponding author, Chih-Hung Chen, upon reasonable request.

Conflicts of Interest

The author declares that they have no conflicts of interest.

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