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Factors influencing blockchain adoption intention in Philippine small and medium enterprises

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ABSTRACT

As an emerging technology, blockchain has huge potential for transforming various industries, such as small and medium enterprises (SMEs). Despite its promising impact, its application in the supply chains of SMEs in developing countries is still in its infancy. This study analyzes the key factors of blockchain adoption intention in Philippine SMEs through an integrated technology-organization-environment (TOE) and technology acceptance model (TAM) with external variables. The data were obtained through a survey of 465 SME practitioners in the national capital region (NCR), Philippines, and analyzed using partial least squares and structural equation modeling (PLS-SEM). In terms of technology dimensions, relative advantage (RLA) had a positive influence on perceived usefulness (PUS) while compatibility (COM) had a positive influence on perceived ease of use (PEU), which both subsequently led to blockchain adoption intention. As regards organization, top management support (TMS) had a significant influence on the adoption intention of blockchain among SMEs. In terms of environment, only competitive pressure (CMP) had significant influence on blockchain adoption intention. In general, most of the hypothesized relationships are significant; thus, SMEs have a positive interest in adopting blockchain technology. Finally, the study serves as baseline evidence of blockchain adoption intention among SMEs in the Philippines.

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1. INTRODUCTION

In the era of digital transformation and rapid technological breakthroughs, traditional paradigms of business management have constantly evolved. The benefits brought by the internet have led to the global application of intelligent and smart tools. This scientific revolution has fueled the development of innovative services and solutions, transforming the existing business landscape [1]. Blockchain is among the most recent developments in the realm of business management.

Blockchain has grown in popularity over the years as this developing technology can revolutionize economies through cost-effective and transparent solutions to a wide range of industries [2]. This technology is characterized as a succession of blocks that record information in the form of hash functions, timestamps, and links to preceding blocks. Thus, this latest innovation provides secure, transparent, and efficient business

processes. However, blockchain adoption remains in its early stages, particularly in developing countries, due to the lack of organizational resources and technological penetration [3].

On a global scale, small and medium enterprises (SMEs) provide an enormous contribution to most thriving economies. They are recognized for their noteworthy contribution to employment and innovation, even despite their small-scale output. Nevertheless, due to evolving business trends, SMEs are confronted by arduous technological and social disruptions. One of the most recent trends in managing SMEs is the application of blockchain [4].

Blockchain adoption among SMEs may result in optimized operations, perhaps leading to improved efficiency and performance. However, in developing countries like the Philippines, there is currently a paucity of evidence that SMEs have integrated blockchain into their supply chains [5]. Therefore, this empirical study analyzes the intent to adopt blockchain in SMEs through an integrated technology-organization-environment (TOE) framework and technology acceptance model (TAM) with external variables. This contributes to the scant studies on blockchain among SMEs in developing countries.

2. RELATED LITERATURE

Blockchain technology was established in the early 1990s as a peer-to-peer transaction network that stores any information and specifies rules for how the information is updated [6]. Its distinct qualities present possible development in managing supply chains as most blockchain transactions are safer and more transparent; hence, harnessing this technology is critical in improving customer responsiveness while also improving the quality of service of SMEs [7].

Further, previous studies have demonstrated that blockchain has a significant influence on supply chain management, which encompasses increased visibility, digitization, data security, and smart contracts [8]. However, given its infancy, it faces different challenges such as regulatory uncertainty and scalability; thus, embracing blockchain is still underway [9]. Recent studies have explored the conceptual level of applying blockchain to meet logistics requirements, but only few have delved into the practitioner's perspective on SMEs in developing countries [10].

Irrespective of whether developing or developed countries, SMEs account for a significant share of the economy. Given the holistic impact of SMEs on job creation and economic development, digital transformation is necessary to enhance efficiency, productivity, and profitability. However, SMEs remain reluctant to embrace digital transformation. Recently, SMEs all around the globe have been disrupted by blockchain technology [11]. However, its adoption in the Philippines is still slow as enterprises focus on survival rather than expansion. According to the current statistics, only 6% of SMEs in the country have advanced digital tools for their firms, while 23% still do not use any digital tools, a phenomenon that may limit the growth of these enterprises [12]. In this regard, empirical study is necessary to fill in this gap in the literature.

2.1. Hypothesis development

This paper examines the key factors influencing blockchain adoption among Filipino SMEs. This considers the TOE framework integrated with the dimensions of TAM and external factors such as data quality, system quality (SQU), and technological volatility. Considering these variables, the study proposes the blockchain technology adoption model in SMEs depicted in Figure 1.

Relative advantage (RLA) is the set of benefits of an innovation that are viewed as outweighing those of existing technology. This is mostly based on perceived benefits such as a quicker response rate, improved reputation, and enhanced customer satisfaction [13]. Previous research has shown that data quality and SQU are two of the well-known RLA of blockchain. Data quality (DQU) has been regarded as a predictor of technology adoption as it is measured by the quality of the output of an information system [14]. On the contrary, SQU is the accessibility of carrying out specific tasks in an information system [15]. Therefore, these primary attributes of RLA have a significant role in creating a well-designed and implemented system, which directly affects the usefulness of blockchain. Thus, the study formulates the following hypotheses:

- H1: data quality and the RLA of blockchain adoption intention among SMEs have a positive relationship.
- H2: SQU and the RLA of blockchain adoption intention among SMEs have a positive relationship.
- H3: RLA and the perceived usefulness (PUS) of blockchain adoption intention among SMEs have a positive relationship.

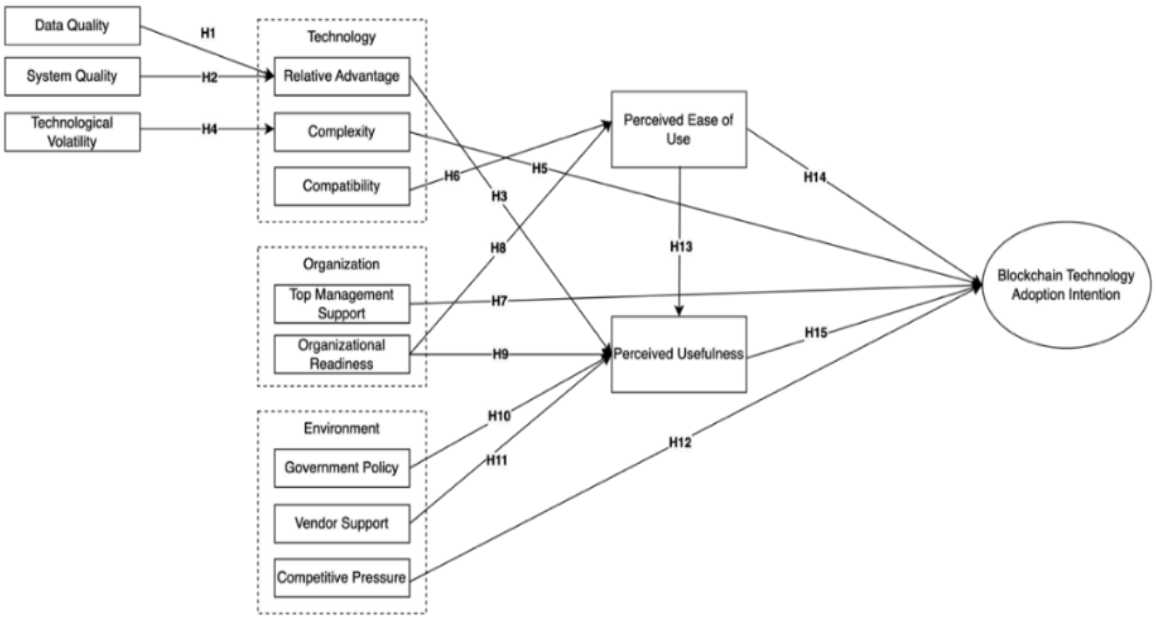

Figure 1. Proposed model on blockchain adoption intention in Philippine SMEs

Complexity (COX) stems from the apparent challenge of comprehending and implementing a new technology. As an emerging technology, blockchain is perceived as risky because of its volatility and security concerns [16]. Technological volatility (TVO) is the uncertainty surrounding the rate of change in technology specifications or developments. Since blockchain is still in its nascent stages, its features are constantly developed and enhanced. Previous research has shown that individuals struggle to understand blockchain technology due to difficult errors in algorithms caused by its volatility. Furthermore, existing research on its COX impedes its deployment in SMEs [17]; thus, the study asserts the following hypotheses:

- H4: TVO and the COX of blockchain adoption intention among SMEs have a positive relationship.
- H5: COX and blockchain adoption intention among SMEs have a negative relationship.

Compatibility (COM) encompasses the current values, past experiences, and demands of consumers in embracing an innovation. Further, it considers corporate objectives, organizational culture, and the availability of technological infrastructure [18]. Previous research on blockchain adoption in SMEs have indicated its positive association with ease of use, making it easier for enterprises to accept blockchain technologies [19]; hence, the study suggests that:

- H6: COM and the perceived ease of use (PEU) of blockchain adoption intention among SMEs have a positive relationship.

One of the most crucial factors in implementing a new technology throughout the organization is top management support (TMS). It refers to how the upper management acknowledges the essence of an innovation and their participation during its implementation [20]. Blockchain is viewed as an investment by the organization, requiring both hardware and software to purchase and deploy the technology, which needs TMS. Thus, it can be hypothesized that:

- H7: TMS and the blockchain adoption intention among SMEs have a positive relationship.

Organizational readiness (ORG) is the feasibility of specific organizational resources such as human resources, financial resources, and infrastructure in implementing new IT advancements [21]. The organization must possess the requisite technological knowledge, training, competency, and skill set to implement blockchain technology. Previous study has shown the willingness of enterprises in adopting blockchain because of its ease of use and usefulness [22]; hence, this asserts that:

- H8: ORG and the PEU of blockchain adoption intention among SMEs have a positive relationship.
- H9: ORG and the PUS of blockchain adoption intention among SMEs have a positive relationship.

Government policy (GPO) refers to policies and norms that influence organizations toward new and innovative technology. Globally, government policies are being used to encourage SMEs to adopt digital technologies like blockchain [23]. Blockchain technology relies on cryptographic signatures and smart contracts, which can be dealt with by government policies and regulations. As a result, the implementation of blockchain to SMEs requires the development of a legal framework to optimize its implementation. Therefore, the study suggests that:

– H10: GPO and the PUS of blockchain adoption intention among SMEs have a positive relationship.

Organizations tend to embrace emerging technologies if they receive vendor support (VSU) such as technical assistance, personalized user trainings, and security controls. According to recent studies, VSU for blockchain adoption is regarded to be useful because it provides technical expertise and troubleshoots difficulties that may affect real-time operations of SMEs [24]. The study asserts that:

– H11: VSU and the PUS of blockchain adoption intention among SMEs have a positive relationship.

Competitive pressure (CMP) entails the desire for a competitive edge that drives businesses to embrace a new technology while responding to changes in the business landscape and industry standards [25]. In terms of blockchain technology adoption, SMEs are driven to implement blockchain technology by the actions of other enterprises in the industry; hence, this study hypothesizes that:

– H12: CMP and the blockchain adoption intention among SMEs have a positive relationship.

PEU is the certainty that an innovation demands less effort from humans. It is also associated with ease of understanding and its functionality. Previous research on blockchain adoption in SMEs has found the direct relationship of ease of use and usefulness [26]. Similarly, it positively affects the willingness to implement blockchain technology in SMEs; hence:

– H13: PEU and the PUS of blockchain adoption intention among SMEs have a positive relationship.
– H14: PEU and the blockchain adoption intention among SMEs have a positive relationship.

PUS is the perception that employing innovative technologies might boost job performance. It is regarded as the most influential predictor of a favorable desire to adopt new technologies [27]. SMEs tend to embrace blockchain when they perceive that it will benefit their organization. Thus, the study implies that:

– H15: PUS and the blockchain adoption intention among SMEs have a positive relationship.

3. MATERIALS AND METHODS

3.1. Survey development

The research instrument was based on the previous research on blockchain adoption among SMEs [28], [29]. The survey has two parts: the demographic profile of the respondents and blockchain adoption intention-related items. The survey uses a seven-point Likert scale to determine whether an individual agrees or disagrees with each item. The adoption intention portion has 44 items. A pilot test of the survey with 50 SMEs was conducted to determine their understanding of each survey item. In addition, it was also submitted to technology-adoption studies experts and management professors for experts' validation. The suggestions and recommendations of these experts were incorporated in the final version of the instrument. The final survey was deployed using Google Forms.

3.2. Participants

The study employed purposive sampling of SMEs from different industries, such as product development, professional services, retail and marketing, and manufacturing. The researchers visited each city in the national capital region (NCR), Philippines to seek assistance in determining respondents to represent SME sectors in the study. An average of 30 SMEs in each city participated in the survey. A total of 465 SME practitioners voluntarily participated in the study.

3.3. Data gathering and analysis

Upon confirmation of participation, the survey link was provided through social media or email, which included the research objectives and informed consent. All participants from SMEs engaged voluntarily in the survey, as evidenced by the consent form and data privacy notice. The survey was conducted from January to March 2024. Two follow-up activities were carried out to increase the response of SME participants. In the end, there are 465 usable survey responses that were analyzed. Of the total respondents, 182 or 39% are male, while 283 or 61% are female. In reference to education level, 357 (77%) hold a bachelor's degree, 93 (20%) are high school graduates and 15 (3%) are master's or doctorate degree holders. Moreover, in terms of age, 407 (88%) are 21–30 years old, 33 (7%) are 31–40 years old, and 25 (5%) are 41–50 years old. The survey data was coded through a spreadsheet before being loaded into SmartPLS 4.0 (smart partial least squares), a software tool for structural equation modeling.

4. RESULTS AND DISCUSSION

4.1. Measurement model

The constructs were examined in terms of their quality, such as Cronbach's alpha (CA), average variance extracted (AVE), composite reliability (CR), and factor loadings (FL), as presented in Table 1. All

values are within the benchmark values [30]; hence the results provide sufficient evidence for the validity and reliability of the constructs.

Further, the study also tested the heterotrait-monotrait ratio of the model, and results show that all values are within the conservative threshold [31], validating the discriminant nature of all the constructs, as presented in Table 2. The descriptive statistics of each construct are likewise assessed, and results show that data quality attained the highest mean ($\bar{x}$=5.96, σ=0.89), while TVO had the lowest mean ($\bar{x}$=5.27, σ=1.37). Meanwhile, the descriptive statistics of other variables are: SQU ($\bar{x}$=5.92, σ=0.88), RLA ($\bar{x}$=5.94, σ=0.89), COM ($\bar{x}$=5.81, σ=0.95), COX ($\bar{x}$=5.28, σ=1.30), TMS ($\bar{x}$=5.73, σ=1.00), ORG ($\bar{x}$=5.63, σ=1.13), CMP ($\bar{x}$= 5.66, σ=1.07), GPO ($\bar{x}$=5.63, σ=1.07), VSU ($\bar{x}$=5.74, σ=0.97), PEU ($\bar{x}$=5.66, σ=1.04), PUS ($\bar{x}$=5.90, σ=0.94), and adoption intention ($\bar{x}$=5.86, σ= 0.95).

Table 1. Quality criteria

Construct	Item	CA (0.6-0.95)	AVE (>0.50)	CR (0.6-0.95)	FL (>0.7)
DQU	3	0.717	0.639	0.841	0.764-0.825
SQU	3	0.737	0.656	0.851	0.788-0.826
TVO	3	0.823	0.740	0.895	0.804-0.887
RLA	4	0.800	0.625	0.870	0.751-0.820
COX	3	0.861	0.783	0.915	0.871-0.905
COM	3	0.769	0.684	0.866	0.821-0.832
TMS	3	0.819	0.735	0.893	0.820-0.898
ORG	3	0.847	0.765	0.907	0.852-0.907
GPO	4	0.842	0.679	0.894	0.790-0.865
VSU	3	0.811	0.727	0.888	0.829-0.895
CMP	3	0.781	0.695	0.872	0.825-0.846
PEU	3	0.815	0.729	0.890	0.848-0.855
PUS	3	0.810	0.725	0.888	0.821-0.870
ADI	3	0.801	0.715	0.883	0.836-0.856

Table 2. Heterotrait-monotrait ratio (<0.85)

Construct	$\bar{x}$	σ	ADI	CMP	COM	COX	DQU	GPO	ORG	PEU	PUS	RLA	SQU	TMS	TVO	VSU
ADI	5.86	0.95														
CMP	5.66	1.07	0.610													
COM	5.81	0.95	0.651	0.595												
COX	5.28	1.30	0.188	0.547	0.209											
DQU	5.96	0.89	0.672	0.602	0.740	0.169										
GPO	5.63	1.07	0.672	0.731	0.626	0.467	0.555									
ORG	5.63	1.13	0.496	0.729	0.369	0.664	0.444	0.610								
PEU	5.66	1.04	0.728	0.583	0.703	0.272	0.515	0.742	0.450							
PUS	5.90	0.94	0.841	0.602	0.654	0.160	0.708	0.644	0.484	0.716						
RLA	5.94	0.89	0.702	0.600	0.820	0.114	0.825	0.589	0.418	0.552	0.791					
SQU	5.92	0.88	0.680	0.533	0.843	0.160	0.849	0.631	0.412	0.554	0.712	0.594				
TMS	5.73	1.00	0.662	0.651	0.717	0.393	0.619	0.730	0.580	0.729	0.599	0.649	0.700			
TVO	5.27	1.37	0.299	0.588	0.368	0.822	0.268	0.504	0.621	0.410	0.213	0.228	0.271	0.485		
VSU	5.74	0.97	0.694	0.709	0.644	0.345	0.528	0.754	0.559	0.757	0.663	0.595	0.588	0.704	0.505	

4.2. Predictive capability analysis

As an important component of the model, its predictive capability through the r^2 values was examined [32]. Accordingly, the explanatory power of the structural model can be explained by the 56% of the variance in the adoption intention of blockchain (r^2=0.561). Moreover, variance in terms of RLA (r^2=0.579), PUS (r^2=0.544), COX (r^2=0.481), and PEU (r^2=0.365) are likewise explained by the model. Additionally, the effect size f^2 which tells whether a construct has a substantive impact on another one was also validated [33]. The results show that TVO (f^2 = 0.927) has the largest f^2 effect size on COX among all the hypothesized relationships in the model, as shown in Table 3.

The study also examined the predictive relevance (Q^2) of the model wherein values above zero indicate well reconstructed values which establish predictive relevance [34]. The results show that RLA (Q^2=0.571) has the largest predictive relevance among the endogenous constructs in the model. Meanwhile, the predictive relevance of other constructs are as follows: PUS (Q^2=0.423), COX (Q^2=0.475), PEU (Q^2=0.350), and adoption intention (Q^2=0.416). Hence, the model establishes the predictive relevance of the endogenous constructs, as depicted in Figure 2.

Table 3. Results of path coefficient and hypothesis testing

Path Coefficient	Coefficient (β)	t-value	p-value	f^2	Result
DQU → RLA	0.264	5.075	0.000	0.096	Supported
SQU → RLA	0.562	11.628	0.000	0.432	Supported
RLA → PUS	0.414	9.096	0.000	0.263	Supported
TVO → COX	0.694	19.203	0.000	0.927	Supported
COX → ADI	-0.051	1.432	0.152	0.005	Not Supported
COM → PEU	0.491	10.624	0.000	0.346	Supported
TMS → ADI	0.159	2.543	0.011	0.032	Supported
ORG → PEU	0.234	4.966	0.000	0.079	Supported
ORG → PUS	0.079	1.594	0.111	0.010	Not Supported
GPO → PUS	0.059	0.875	0.382	0.004	Not Supported
VSU → PUS	0.091	1.436	0.151	0.009	Not Supported
CMP → ADI	0.119	2.231	0.026	0.018	Supported
PEU → PUS	0.282	4.509	0.000	0.092	Supported
PEU → ADI	0.181	3.651	0.000	0.039	Supported
PUS → ADI	0.459	8.732	0.000	0.276	Supported

Note: significant at p-value < 0.05

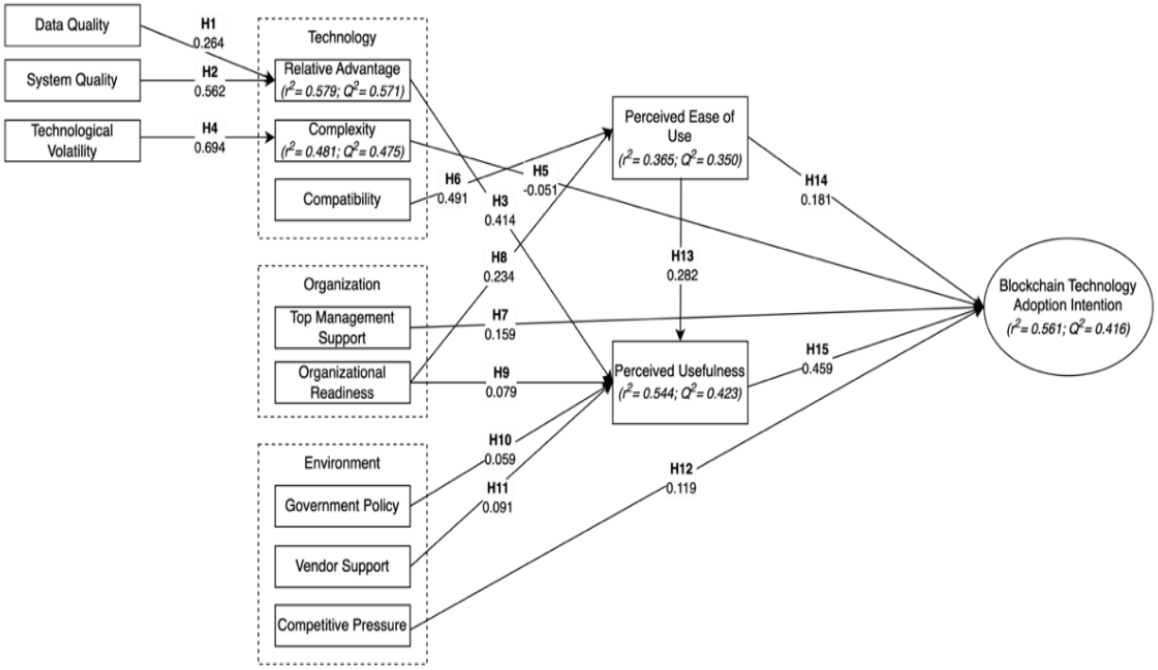

Figure 2. Research model on blockchain adoption intention in Philippine SMEs

4.3. Structural model

This paper explores the key factors of blockchain adoption intention among SMEs, which is relatively underexplored in the Philippines and other developing countries. The structural relationships which include the results of path coefficients and the hypothesis testing are presented in Table 3. Based on the results, the majority of the predicted relationships have positive relationships, which implies a positive interest in blockchain adoption among Philippine SMEs.

First, data quality (H1, β= 0.264, p= 0.000) and SQU (H2, β=0.562, p=0.000) positively influenced the RLA of blockchain adoption in SMEs. The RLA (H3, β=0.414, p=0.000) had a direct influence on the PUS of blockchain adoption intention among SMEs. These findings are consonant with recent studies emphasizing that data and SQU are essential features in determining the RLA of blockchain technology [35]. Similarly, the RLA that blockchain offers is deemed useful by business enterprises; hence, H1, H2, and H3 are supported.

Second, TVO (H4, β=0.694, p=0.000) significantly influenced complexity. The findings are in line with earlier research indicating the COX of blockchain due to its volatility since it is still in its infancy [36];

thus, H4 is supported. On the contrary, COX (H5, β=-0.051, p=0.152) negatively influenced the blockchain adoption intention. The negative influence of COX is insignificant, indicating that SMEs found no difficulty in implementing blockchain. This may suggest that the perceived COX of blockchain technology is not a significant barrier for SMEs in the NCR, potentially due to their familiarity with emerging technologies or the availability of resources and support systems that mitigate implementation challenges. Hence, H5 is not supported.

Third, COM (H6, β=0491, p=0.000) and PEU had a direct relationship. This validates the results of prior research, which confirmed that organizational culture and technological infrastructure, which are indicators of compatibility, have a significant effect on the ease of use of blockchain [37]. The positive relationship observed suggests that when blockchain technology aligns with the organization's existing practices and infrastructure, users are more likely to perceive it as easy to use, further reinforcing the compatibility-ease of use link. Hence, H6 is supported.

Fourth, TMS (H7, β=0.159, p=0.011) significantly influenced the adoption intention of blockchain. This supports previous investigations highlighting the essential role and involvement of top management in adopting innovative technologies such as blockchain [38]. The significant effect observed underscores that leadership commitment and resources are crucial in fostering a conducive environment for the successful adoption and integration of emerging technologies like blockchain. Consequently, H7 is supported.

Fifth, ORG (H8, β=0.234, p=0.000) and PEU had a positive relationship. The result adheres with previous research emphasizing that enterprises should have adequate resources such as financial and technological resources when implementing new technology such as blockchain [39]; thus, H8 is supported. On the contrary, ORG (H9, β=0.079, p=0.111) and the PUS of blockchain had an insignificant relationship, contradicting previous adoption intention studies. This result may indicate that, for SMEs in the NCR, factors such as resource availability or organizational culture may play a more critical role in adoption decisions than the PUS of the technology itself, suggesting that other contextual elements might better explain the adoption process. Therefore, H9 is not supported.

Sixth, GPO (H10, β=0.059, p=0.382) and VSU (H11, β=0.091, p=0.151) had insignificant influence on perceived usefulness. These results contradict prior research that stressed the importance of government and VSU in the implementation of blockchain [40]. This may suggest that, within the context of SMEs in the NCR, other factors such as internal capabilities, market dynamics, or industry-specific needs might play a more prominent role in shaping the perception of blockchain's usefulness, rather than external support mechanisms. Hence, H10 and H11 are not supported. On the contrary, CMP (H12, β=0.119, p=0.026) had a positive relationship on the adoption intention of blockchain. This validates previous studies, which assert the drive of enterprises to embrace blockchain in response to the actions of industry competitors [41]. The significant positive relationship suggests that when organizations perceive competitors adopting blockchain, they are more likely to follow suit to avoid falling behind, thereby increasing their own adoption intention. Hence, H12 is supported.

Lastly, PEU (H13, β=0.282, p=0.000) and perceived usefulness of blockchain technology adoption intention had a significant relationship. Likewise, ease of use (H14, β=0.181, p=0.000) and usefulness (H15, β=0.459, p=0.000) also had a significant relationship with blockchain adoption intention. These findings align with the Technology Acceptance Model, which suggests that both ease of use and perceived usefulness are key determinants in shaping individuals' intention to adopt new technologies. The significant relationships observed in all three hypotheses highlight that when blockchain technology is perceived as easy to use and beneficial, the intention to adopt it increases. Therefore, H13, H14, and H15 are supported.

4.4. Implications

This preliminary work contributes to both theory and practice. On theoretical aspects, this study integrates the TOE framework with TAM, together with external variables to provide empirical evidence of blockchain adoption intention among SMEs. This integration resulted in the development of a more comprehensive model that offers a holistic understanding of blockchain adoption in SMEs, which considers individual-level acceptance with organizational factors, and environmental influences. In terms of its practical implications, the study offers valuable insights from SME practitioners, which highlights the potential of blockchain in reshaping the business landscape and creating opportunities for growth and innovation. The additional factors incorporated into the model offer a better understanding of the predictors of adoption intention from the perspective of SMEs in developing nations. This comprehensive approach enhances the validity and relevance of this study. Lastly, the study provides baseline evidence to SME stakeholders in the Philippines, which showcases the promising implementation of blockchain.

Despite its significant contribution, there are some hypothesized relationships in the integrated model that were not supported. The insignificant relationship between COX (a technology dimension) and blockchain adoption intention provides valuable insights for SME practitioners regarding their willingness to adopt blockchain technology despite its inherent complexity. On the other side, the insignificant relationships

between ORG (an organizational dimension) and GPO and VSU (environmental dimensions) to perceived usefulness of blockchain suggest that these factors should be strengthened and given emphasis, especially in developing countries like the Philippines. In such contexts, enterprises should be equipped with the necessary resources, including financial resources and technological infrastructure, to effectively manage the adoption and utilization of this new technology. Additionally, the government policymakers hold a pivotal role in developing policies and frameworks that encourage blockchain adoption. Besides, due to the infancy of blockchain technology, SMEs should seek support from vendors throughout the adoption process until its successful implementation within the organization. Generally, these findings emphasize the importance of technological support in adopting the COX of the system, organizational support in ensuring organizational readiness, and environmental support from the government and vendors for the successful adoption of blockchain among SMEs.

5. CONCLUSION

Blockchain is an emerging technology in developing countries. However, there are challenges present before its adoption and continuance in many enterprises, such as SMEs. Therefore, this study presents baseline evidence on blockchain adoption intention using TOE model integrated with TAM to determine the role of each factor in its adoption. As regards the technology dimension, RLA had a positive influence on perceived usefulness while COM had a positive influence on PEU which both subsequently led to blockchain adoption intention. On the contrary, COX had an insignificant influence on blockchain adoption intention; thus, it may be inferred that SME practitioners are willing to adopt blockchain despite its inherent complexity. In terms of organization, TMS had a significant influence on the adoption intention of blockchain among SMEs. Furthermore, ORG had a positive relationship with PEU but not with perceived usefulness leading to blockchain adoption intention. Meanwhile, in terms of environment, only CMP had significant influence on blockchain adoption intention. In general, most of the hypothesized relationships are significant; thus, SMEs have shown a positive interest in adopting blockchain technology.

The study contributes to certain aspects; nevertheless, further extension could be undertaken to improve its contribution. Firstly, the study focused only on SMEs in the NCR; hence, the result may not be generalizable to the broader SME population. As such, the results should be interpreted with caution, as blockchain adoption may vary significantly across different regions and industries. Further investigations may be undertaken in other parts of the country to enhance the findings. Second, the study focused on technology dimensions such as data quality, SQU, and TVO of the TOE model. Future studies may identify other factors for organization and environmental dimensions. In addition, since blockchain enhances interorganizational collaboration, future research could delve into incorporating the role of trust, security, and data integrity in SME adoption. Finally, future work may involve longitudinal studies to further understand blockchain adoption which may enhance the empirical results of this preliminary investigation.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

DATA AVAILABILITY

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

REFERENCES

[1] D. Kimani, K. Adams, R. Attah-Boakye, S. Ullah, J. Frecknall-Hughes, and J. Kim, "Blockchain, business and the fourth industrial revolution: Whence, whither, wherefore and how?," *Technological Forecasting and Social Change*, vol. 161, Dec. 2020, doi: 10.1016/j.techfore.2020.120254.

[2] I. Abrar and J. A. Sheikh, "Current trends of blockchain technology: architecture, applications, challenges, and opportunities," *Discover Internet of Things*, vol. 4, no. 1, Jul. 2024, doi: 10.1007/s43926-024-00058-5.

[3] R. Teeluck, S. Durjan, and V. Bassoo, "Blockchain technology and emerging communications applications," in *Security and Privacy Applications for Smart City Development*, 2021, pp. 207–256. doi: 10.1007/978-3-030-53149-2_11.

[4] P. Dutta, T.-M. Choi, S. Somani, and R. Butala, "Blockchain technology in supply chain operations: Applications, challenges and research opportunities," *Transportation Research Part E: Logistics and Transportation Review*, vol. 142, Oct. 2020, doi: 10.1016/j.tre.2020.102067.

[5] P.-K. Chen, Q.-R. He, and S. Chu, "Influence of blockchain and smart contracts on partners' trust, visibility, competitiveness, and environmental performance in manufacturing supply chains," *Journal of Business Economics and Management*, vol. 23, no. 4, pp. 754–772, Mar. 2022, doi: 10.3846/jbem.2022.16431.

[6] A. Kumar, S. K. Srivastava, and S. Singh, "How blockchain technology can be a sustainable infrastructure for the agrifood supply chain in developing countries," *Journal of Global Operations and Strategic Sourcing*, vol. 15, no. 3, pp. 380–405, Aug. 2022, doi: 10.1108/JGOSS-08-2021-0058.

[7] L. J. Cueto, A. F. D. Frisnedi, R. B. Collera, K. I. T. Batac, and C. B. Agaton, "Digital innovations in MSMEs during economic disruptions: Experiences and challenges of young entrepreneurs," *Administrative Sciences*, vol. 12, no. 1, Jan. 2022, doi: 10.3390/admsci12010008.

[8] L.-W. Wong, L.-Y. Leong, J.-J. Hew, G. W.-H. Tan, and K.-B. Ooi, "Time to seize the digital evolution: Adoption of blockchain in operations and supply chain management among Malaysian SMEs," *International Journal of Information Management*, vol. 52, Jun. 2020, doi: 10.1016/j.ijinfomgt.2019.08.005.

[9] M. AlShamsi, M. Al-Emran, and K. Shaalan, "A systematic review on blockchain adoption," *Applied Sciences*, vol. 12, no. 9, Apr. 2022, doi: 10.3390/app12094245.

[10] S. Rakshit, A. Jeyaraj, and T. Paul, "SME performance through blockchain technologies," *Journal of Computer Information Systems*, vol. 64, no. 2, pp. 204–218, Mar. 2024, doi: 10.1080/08874417.2023.2187482.

[11] E. Bracci, M. Tallaki, R. Ievoli, and S. Diplotti, "Knowledge, diffusion and interest in blockchain technology in SMEs," *Journal of Knowledge Management*, vol. 26, no. 5, pp. 1386–1407, Apr. 2022, doi: 10.1108/JKM-02-2021-0099.

[12] S. Bag, M. S. Rahman, S. Gupta, and L. C. Wood, "Understanding and predicting the determinants of blockchain technology adoption and SMEs' performance," *The International Journal of Logistics Management*, vol. 34, no. 6, pp. 1781–1807, Dec. 2023, doi: 10.1108/IJLM-01-2022-0017.

[13] K. Molati, A. Ifeanyi Ilorah, and M. Nthabiseng Moeti, "Determinant factors influencing the adoption of blockchain across SMEs in South Africa," in *2021 15th International Conference on Advanced Technologies, Systems and Services in Telecommunications (TELSIKS)*, Oct. 2021, pp. 265–269. doi: 10.1109/TELSIKS52058.2021.9606343.

[14] S. Malik, M. Chadhar, S. Vatanasakdakul, and M. Chetty, "Factors affecting the organizational adoption of blockchain technology: Extending the technology–organization–environment (TOE) framework in the Australian context," *Sustainability*, vol. 13, no. 16, Aug. 2021, doi: 10.3390/su13169404.

[15] N. Chonsawat and A. Sopadang, "Defining SMEs' 4.0 readiness indicators," *Applied Sciences*, vol. 10, no. 24, Dec. 2020, doi: 10.3390/app10248998.

[16] A. T. F. Lou and E. Y. Li, "Integrating innovation diffusion theory and the technology acceptance model: The adoption of blockchain technology from business managers' perspective," in *Proceedings of The 17th International Conference on Electronic Business*, 2017, pp. 293–296.

[17] M. Iranmanesh, P. Maroufkhani, S. Asadi, M. Ghobakhloo, Y. K. Dwivedi, and M.-L. Tseng, "Effects of supply chain transparency, alignment, adaptability, and agility on blockchain adoption in supply chain among SMEs," *Computers & Industrial Engineering*, vol. 176, Feb. 2023, doi: 10.1016/j.cie.2022.108931.

[18] N. Deng, Y. Shi, J. Wang, and J. Gaur, "Testing the adoption of blockchain technology in supply chain Management among MSMEs in China," *Annals of Operations Research*, Aug. 2022, doi: 10.1007/s10479-022-04856-4.

[19] F. Lanzini, J. Ubacht, and J. De Greeff, "Blockchain adoption factors for SMEs in supply chain management," *Journal of Supply*

Chain Management Science, vol. 2, no. 1–2, pp. 47–68, 2021, doi: 10.18757/JSCMS.2021.5624.
[20] N. Alshareef and M. N. Tunio, "Role of leadership in adoption of blockchain technology in small and medium enterprises in Saudi Arabia," *Frontiers in Psychology*, vol. 13, May 2022, doi: 10.3389/fpsyg.2022.911432.
[21] I. K. A. Hamdan, W. Aziguli, D. Zhang, E. Sumarliah, and K. Usmanova, "Forecasting blockchain adoption in supply chains based on machine learning: evidence from Palestinian food SMEs," *British Food Journal*, vol. 124, no. 12, pp. 4592–4609, Nov. 2022, doi: 10.1108/BFJ-05-2021-0535.
[22] H. Khazaei, "Integrating cognitive antecedents to UTAUT model to explain adoption of blockchain technology among Malaysian SMEs," *JOIV : International Journal on Informatics Visualization*, vol. 4, no. 2, pp. 85–90, May 2020, doi: 10.30630/joiv.4.2.362.
[23] A. Rijanto, "Blockchain technology adoption in supply chain finance," *Journal of Theoretical and Applied Electronic Commerce Research*, vol. 16, no. 7, pp. 3078–3098, Nov. 2021, doi: 10.3390/jtaer16070168.
[24] P. Shrivastava, "Environmental technologies and competitive advantage," *Business Ethics and Strategy, Volumes I and II*, pp. 317–334, 2018.
[25] H. Tennakoon, J. M. Hansen, G. Saridakis, M. Samaratunga, and J. W. Hansen, "Drivers and barriers of social sustainable development and growth of online higher education: The roles of perceived ease of use and perceived usefulness," *Sustainability*, vol. 15, no. 10, May 2023, doi: 10.3390/su15108319.
[26] M. Sciarelli, A. Prisco, M. H. Gheith, and V. Muto, "Factors affecting the adoption of blockchain technology in innovative Italian companies: An extended TAM approach," *Journal of Strategy and Management*, vol. 15, no. 3, pp. 495–507, 2022.
[27] K. M. S. Faqih, "Which is more important in e-learning adoption, perceived value or perceived usefulness? Examining the moderating influence of perceived compatibility," *GSE E-Journal of Education*, vol. 4, pp. 37–67, 2016.
[28] A. Kumar Bhardwaj, A. Garg, and Y. Gajpal, "Determinants of blockchain technology adoption in supply chains by small and medium enterprises (SMEs) in India," *Mathematical Problems in Engineering*, vol. 2021, pp. 1–14, Jun. 2021, doi: 10.1155/2021/5537395.
[29] M. Dehghani, R. William Kennedy, A. Mashatan, A. Rese, and D. Karavidas, "High interest, low adoption. A mixed-method investigation into the factors influencing organisational adoption of blockchain technology," *Journal of Business Research*, vol. 149, pp. 393–411, Oct. 2022, doi: 10.1016/j.jbusres.2022.05.015.
[30] M. Sarstedt, C. M. Ringle, and J. F. Hair, "Partial least squares structural equation modeling," in *Handbook of Market Research*, Cham: Springer International Publishing, 2017, pp. 1–40. doi: 10.1007/978-3-319-05542-8_15-1.
[31] M. Rönkkö and E. Cho, "An updated guideline for assessing discriminant validity," *Organizational Research Methods*, vol. 25, no. 1, pp. 6–14, Jan. 2022, doi: 10.1177/1094428120968614.
[32] J. F. Hair, G. T. M. Hult, C. M. Ringle, M. Sarstedt, N. P. Danks, and S. Ray, "Evaluation of the structural model," in *Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R*, 2021, pp. 115–138. doi: 10.1007/978-3-030-80519-7_6.
[33] S. Shanmugapriya and K. Subramanian, "Structural equation model to investigate the factors influencing quality performance in Indian construction projects," *Sadhana*, vol. 40, no. 6, pp. 1975–1987, Sep. 2015, doi: 10.1007/s12046-015-0421-3.
[34] M. Gotthardt and V. Mezhuyev, "Measuring the success of recommender systems: A PLS-SEM approach," *IEEE Access*, vol. 10, pp. 30610–30623, 2022, doi: 10.1109/ACCESS.2022.3159652.
[35] L. Lu, C. Liang, D. Gu, Y. Ma, Y. Xie, and S. Zhao, "What advantages of blockchain affect its adoption in the elderly care industry? A study based on the technology–organisation–environment framework," *Technology in Society*, vol. 67, Nov. 2021, doi: 10.1016/j.techsoc.2021.101786.
[36] E. Toufaily, T. Zalan, and S. Ben Dhaou, "A framework of blockchain technology adoption: An investigation of challenges and expected value," *Information & Management*, vol. 58, no. 3, Apr. 2021, doi: 10.1016/j.im.2021.103444.
[37] A. Muayad Younus and V. Raju, "Resilient features of organizational culture in implementation of smart contract technology blockchain in Iraqi gas and oil companies," *International Journal for Quality Research*, vol. 15, no. 2, pp. 435–450, May 2021, doi: 10.24874/IJQR15.02-05.
[38] A. Happy, M. M. H. Chowdhury, M. Scerri, M. A. Hossain, and Z. Barua, "Antecedents and consequences of blockchain adoption in supply chains: A systematic literature review," *Journal of Enterprise Information Management*, vol. 36, no. 2, pp. 629–654, Jan. 2023, doi: 10.1108/JEIM-03-2022-0071.
[39] X. Pan, X. Pan, M. Song, B. Ai, and Y. Ming, "Blockchain technology and enterprise operational capabilities: An empirical test," *International Journal of Information Management*, vol. 52, Jun. 2020, doi: 10.1016/j.ijinfomgt.2019.05.002.
[40] M. El Khatib, A. Al Mulla, and W. Al Ketbi, "The role of blockchain in e-governance and decision-making in project and program management," *Advances in Internet of Things*, vol. 12, no. 03, pp. 88–109, 2022, doi: 10.4236/ait.2022.123006.
[41] X.-Y. Wu, Z.-P. Fan, and G. Li, "Strategic analysis for adopting blockchain technology under supply chain competition," *International Journal of Logistics Research and Applications*, vol. 26, no. 10, pp. 1384–1407, Oct. 2023, doi: 10.1080/13675567.2022.2058473.

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