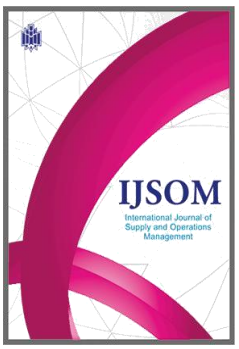
International Journal of Supply and Operations Management

IJSOM

2025, Volume 12, Issue 3, pp. 293-317
ISSN-Print: 2383-1359
ISSN-Online: 2383-2525
www.ijsom.com



Blockchain Applications in Value Added Tax Refund: A Deep Learning-Based Dual-Stage SEM-ANN Analysis

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Abstract

This study examines the determinants of businesses' readiness to implement blockchain technology for value-added tax (VAT) refunds. This study enhances Technology Acceptance Model 2 (TAM2) by incorporating the concept of perceived risk into the framework. This study utilized a two-stage approach that integrated Partial Least Squares Structural Equation Modeling (PLS-SEM) with Artificial Neural Network (ANN) predictive analytics to test the proposed hypotheses. The ANN technique was employed to identify and analyze the potential nonlinear effects within the model. A total of 175 self-administered questionnaires were used for the analysis. The study found that a significant relationship between TAM2s' constructs and intention to use blockchain technology can markedly enhance the efficiency of VAT refund operations from a managerial standpoint. The theoretical implications of blockchain technology are substantial, as it introduces novel concepts of trust and accountability in tax interactions, disrupts traditional intermediaries, modifies the balance of information, and redefines contract enforcement.

Keywords: SEM-ANN Analysis; Blockchain; TAM2; VAT; Vietnam.

1. Introduction

Governments impose financial charges on individuals and entities through taxation (Q. Wang et al., 2021). This practice is common in most countries and aims to generate income for government spending on infrastructure and public services (Gu, 2021). VAT is a tax. VAT is a consumption tax included in product prices in multiple stages. VAT refunds are crucial for import-export businesses. Exported goods and services are usually VAT-free, which encourages international trade (Prasad et al., 2023). Exporters can claim that VAT refunds production inputs to reduce their tax burdens. Businesses often pay VAT at their point of entry when importing goods. However, some jurisdictions allow VAT to refund or credit imported goods, thus preventing double taxation. These VAT refund mechanisms boost international trade and show how tax policies affect it (Nguyen et al., 2019). In Vietnam, the VAT refund process is hampered by the tax authority's suspicion that a business entity within the enterprise's network has relocated, whether the goods are genuine or counterfeit, whether the buyers are reputable, and their uncertainty about the source of purchased goods (Viet & Huong, 2023). Instead of receiving immediate refunds, the affected businesses must undergo approval and verification processes and audits. Therefore, blockchain is required for VAT refunds to reduce the administrative burden on businesses and tax collectors.

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DOI: 10.22034/ijsom.2025.110332.3054

Blockchain, a P2P digital ledger, uses cryptography, a Public Key Infrastructure, and hashing (Queiroz & Fosso Wamba, 2019). This technology records blocks of transactions in real time across a blockchain network among authorized participants (Wong et al., 2019). The elimination of centralized third-party verification is significant. This innovative approach helped decentralize the economy. Blockchain improves security and transparency, making it ideal for financial and banking applications (Nguyen & Nguyen, 2021). Blockchain technology offers many benefits for VAT refunds. Blockchain technology uses a distributed ledger to transparently and securely record transactions. This allows tax authorities and businesses to verify cross-border VAT refund claims. Pal et al. (2021) find that smart contracts automate refund calculations and approvals based on predetermined conditions, thereby increasing productivity. Thus, manual intervention was reduced. Blockchain reduces errors and fraud by maintaining accurate and uniform data. Decentralized blockchains eliminate intermediaries, simplify processes, and reduce administrative burdens. Technology also enables secure authentication and verification of supporting documents, reduces fraudulent claims, and ensures regulatory compliance (Nguyen et al., 2023). Real-time updates allow stakeholders to track refund requests and to improve transparency and communication. These advantages are promising, but their implementation requires overcoming several obstacles, including technology adoption, regulatory compliance, scaling, technical expertise, and system compatibility (Flovik et al., 2021).

A thorough review of taxation and blockchain research has identified key gaps in the literature. First, while previous studies have explored the integration of blockchain technology in Value-Added Tax (VAT) systems, much of the research remains conceptual. Ainsworth et al. (2018) highlight blockchain's potential to reduce the VAT gap without imposing additional administrative burdens on businesses. Ntaliani and Costopoulou (2018) demonstrate blockchain-based tools that reduce SMEs' information retrieval costs. Furthermore, research on blockchain-enabled VAT systems in Indonesia and Saudi Arabia (Wijaya et al., 2017; Alkhodre et al., 2019) and Phadke et al.'s (2021) Ethereum-based VAT compliance prototype show promising applications. However, these studies primarily focus on theoretical frameworks and prototype models, lacking empirical validation across diverse business environments. Given that VAT refund processes involve complex regulatory, technological, and behavioral factors, empirical research is essential to evaluate blockchain's real-world feasibility, adoption, and effectiveness. Second, in tax compliance research, Hyvärinen et al. (2017) present a blockchain-based IT artifact aimed at preventing double-dividend taxation, marking one of the earliest practical applications of blockchain in public-sector taxation. They argue that VAT settlement via blockchain is a logical step to balancing business compliance requirements with administrative efficiency. Since VAT refunds are crucial for business cash flow management, risk reduction, and financial flexibility (Naritomi, 2019; Gu, 2021), blockchain has the potential to enhance transparency, accuracy, and efficiency in refund processes (Wang et al., 2021). However, despite this potential, research on blockchain-driven VAT refunds remains scarce, particularly in terms of business adoption drivers, risk perceptions, and regulatory challenges (Hasan et al., 2022; Phadke, 2021). Third, in Vietnam, VAT refund delays are a persistent issue due to tax authorities' concerns about business relocations, unclear company addresses, and fraud risks (Viet & Huong, 2023). These challenges create inefficiencies in tax administration and increase compliance costs for businesses. While blockchain could streamline VAT refunds by enhancing traceability, automation, and fraud prevention, little research has explored its adoption in Vietnam's tax ecosystem. Thus, this study aims to fill this gap by examining the potential benefits, challenges, and motivations influencing blockchain adoption for VAT refunds, contributing to a deeper understanding of emerging technologies in financial and tax administration.

This study applies the Technology Acceptance Model 2 (TAM2) to examine blockchain adoption in VAT refunds, addressing key research gaps. To enhance analytical rigor, the study employs a PLS-SEM–ANN approach, which allows for a more accurate assessment of both linear and nonlinear relationships in the data. TAM2 extends the original Technology Acceptance Model (TAM) by incorporating social influence and cognitive instrumental processes, offering a more comprehensive framework for understanding technology adoption. This study makes a meaningful contribution by extending the Technology Acceptance Model 2 (TAM2) with perceived risk to examine blockchain adoption for VAT refunds, an area that remains underexplored in the existing literature. While previous research has examined blockchain applications in taxation (Ainsworth et al., 2018; Wang et al., 2021), few studies have provided empirical validation of blockchain adoption specifically for VAT refunds. By incorporating perceived risk, this study enriches the TAM2 framework, acknowledging the significant role of security concerns, privacy issues, and trust in shaping businesses' adoption decisions (Giovanis et al., 2021; Wong et al., 2021). Methodologically, the PLS-SEM–ANN approach enhances analytical depth by capturing both linear and nonlinear relationships, offering a more nuanced understanding of adoption drivers compared to traditional statistical methods. Practically, the study provides valuable insights for policymakers and tax authorities on how blockchain can address VAT refund delays, enhance

transparency, and improve compliance—critical challenges in countries like Vietnam (Viet & Huong, 2023). By bridging the gap between technological advancements and financial policy, this research advances knowledge in both blockchain adoption and tax administration, making it a timely and relevant contribution to the field.

2. Literature review and hypotheses development

2.1 Technology Acceptance Model (TAM) 2

The Technology Acceptance Model (TAM), based on Davis's (1989) theory of reasoned action (TRA), uses proven behavioral principles and research. Chatterjee et al. (2020) noted its widespread use in predicting user behavior regarding IS acceptance. The TAM's two core elements, perceived usefulness (PEU) and perceived ease of use (PEOU), strongly influence technology adoption. The original framework was flawed. Tan and Ooi (2018) noted the lack of external variables, while Venkatesh et al. (2012) noted its oversimplification and limited real-world applicability. According to Legris et al. (2003), exogenous factors may affect TAM's fundamental components. According to Wu et al. (2011), subjective norms affect PU, PEOU, and adoption intentions. According to Ooi and Tan (2016), the TAM's original workplace-centric scope may not include consumer decision-making. Chen et al. (2009) state that TAM only explains 40% of the variance, and Bagozzi (2007) criticizes its unidimensional acceptance construct.

TAM's predictive power of TAM in modern contexts depends on external variable integration (Yap et al., 2017). Previous research has added constructs to the TAM despite its limitations (Magni & Sestino, 2021). According to Bailey et al. (2017), privacy and experience factors affect attitudes toward mobile payment users. Masudin et al. (2021) added social influence to TAM to show how humanitarianism affects logistics blockchain adoption. These changes enable objective blockchain acceptance and VAT refund taxation evaluations. Venkatesh and Davis (2000) introduced TAM2, an enhanced conceptual framework that includes subjective norms, voluntariness, image, job relevance, result demonstrability, output quality, and experience to address the limitations of the original Technology Acceptance Model (TAM). According to Wu et al. (2011), Technology Acceptance Model 2 (TAM2) explains 20% more than the original model does. Across industries, this extended methodology has been used to study consumer acceptance of information and communication technologies. According to Knoesen and Seymour (2019), TAM2's exogenous factors—image, job relevance, and social norms—significantly affect perceived usefulness. In South Africa, this perception affects the adoption of mobile enterprise apps. Sharifzadeh et al. (2017), Kamble et al. (2019), and Paramaeswari and Sarno (2020) demonstrated that TAM2 is applicable to e-commerce, agriculture, and supply chains. This study analyzes the TAM2 factors of subjective norms, voluntariness, experience, image, job relevance, perceived ease of use, perceived usefulness, and perceived risk to assess blockchain technology's VAT refund acceptance.

2.2 Blockchain applications in VAT

The decentralized and distributed digital ledger technology blockchain can revolutionize finance and taxation. Blockchains have several VAT applications. Blockchain makes the VAT transaction documentation transparent and immutable. This transparent method improved the administration and collection of the VAT. Real-time transaction data reduces underreporting and tax evasion (Prasad et al., 2023). According to Wijaya et al. (2017), blockchain technology automates VAT transaction computations, verifications, and recordkeeping, simplifying VAT payment and collection, and smart contracts deduct VAT automatically, ensuring fast and accurate payment processing. Blockchain technology enhances VAT refunds, especially international refunds. Alkhodre et al. (2019) recommend storing supply chains and export-import paperwork in a distributed ledger system to help tax authorities validate their VAT refund claims. This approach may reduce fraudulent administrative costs and risks. VAT processes are automated using blockchain technology, eliminating paperwork and manual verification. According to Ainsworth et al. (2018), automation may aid businesses and tax authorities in their administrative tasks. Blockchain immutability and cryptography prevent VAT fraud such as fake invoicing and multiple refund claims (Hyvärinen et al., 2017). Businesses and tax authorities can access transaction data instantly using blockchain technology to improve reporting, audits, and compliance. Blockchain allows uniform and transparent transaction documentation and validation across legal jurisdictions. International VAT compliance has been streamlined (Alkhodre et al., 2019). VAT data are encrypted using a blockchain. Access permissions selectively grant authorized entities access to sensitive data (Namasudra et al., 2023).

2.3 Hypotheses development

2.3.1 Intention to use (IUS)

User adoption of new Information Systems depends on many factors. Kamble et al. (2019) show that PEU and PEOU influence Indian consumers' blockchain supply chain adoption intentions. The blockchain technology for tax refunds may provide consumers with streamlined and efficient refund procedures, reduced paperwork, faster processing times, and increased transparency (Hyvärinen et al., 2017). Suppose that companies believe that blockchain technology will outperform traditional methods. If so, they would be more likely to like and implement them. PEOU also examines how businesses view blockchain technology's tax refund simplicity and usability (Tan et al., 2010). Businesses are more likely to adopt technologies that are easy to understand, navigate, and use. If blockchain technology is easy to implement and does not require technical expertise, businesses are more likely to use it for tax refunds (Prasad et al., 2023). We propose the following hypothesis:

H1: IUS has a positive impact on the use behavior (UB) of blockchain in VAT refunds.

2.3.2 Subjective norm (SUN)

Subjective Norms (SUN) stem from Ajzen's (2012) planned behavior theory. SUN includes people's perceptions of social pressure as a driver of certain behaviors (Y. Wang et al., 2019). According to Dong et al. (2021), collective judgment and socialization often justify personal decisions. SUN has been used in the research on blockchain acceptance. Bagozzi (2007) states that it drives social technological acceptance. Opinion leaders and interpersonal influences also predict consumer information-seeking and sharing (L.-T. Nguyen, Nguyen, et al., 2023). Kamble et al. (2019) claim that peer opinions influence behavior; therefore, social networks increase blockchain adoption. Therefore, SUN may be an antecedent to IUS. Bittner and Shipper (2014) also found a positive relationship between SUN and business PEU in gamified product ads, suggesting that PU may be affected. SUN can also affect image (IMG), which describes a person's social standing as shaped by their responses to others' influence. SUN may improve an individual's image because people often act to maintain or improve their social status (Khan & Sukhotu, 2020). Following this logic, the following hypothesis was developed:

H2: SUN has a positive impact on IUS

H3: SUN has a positive impact on PEU

H4: SUN has a positive impact on IMG

2.3.3 Voluntariness (VOL)

Voluntariness (VOL) plays a significant role in the context of blockchains for Value-Added Tax (VAT). VOL refers to the voluntary nature of technology adoption and is typically discussed within organizational contexts (Maruping et al., 2017). In the context of value-added tax and blockchain, VOL refers to the degree to which businesses voluntarily integrate blockchain technology into VAT-related processes. The decision to adopt blockchain technology for VAT may be influenced by external factors such as societal pressures or the desire to conform to contemporary technological trends (Prasad et al., 2023). Similar to how users may feel compelled to adopt technology due to perceived pressures, businesses may adopt blockchain for VAT processes for reasons such as regulatory compliance, efficiency gains, and competitive positioning (Phadke et al., 2021). Therefore, voluntariness in the blockchain-for-VAT context refers to businesses deliberate and self-determined decisions to incorporate blockchain technology into their VAT operations, motivated by internal and external factors. As a result, the following hypothesis is proposed:

H5: VOL moderates the relationship between SUN and IUS

2.3.4 Experience (EXP)

Additionally, empirical evidence suggests that experience (EXP) with a system significantly affects technology acceptance. Notably, as experience increases,'sN the influence on intention diminishes (Komulainen & Nätti, 2023). Venkatesh and Davis (2000), who identified EXP as a moderator of the relationship between SUN and Intention to Use (IUS), supported this notion (Venkatesh & Davis, 2000). Similarly, the influence of subjective norms on Perceived Usefulness (PEU) and Intention to Use (IUS) decreases as users' familiarity with and comprehension of blockchain in VAT refunds increases (Venkatesh & Davis, 2000). Based on this justification, the following hypothesis is proposed:

H6: EXP moderates the relationship between SUN and IUS

H7: EXP moderates the relationship between SUN and PEU

2.3.5 Image (IMG)

Moore and Benbasat (1991, p.195) defined IMG as how people think that adopting a new technology will boost their social status. Technology Acceptance Model 2 (TAM2) states that adopting a technology will boost social status or identity (Venkatesh & Davis, 2000). Alwabel and Zeng (2021) also emphasize the role of specific technological usage in creating a sense of belonging to a collective, boosting users perceived social status by associating it with esteemed technologies. Hew et al. (2019) found that people who know about an ' electric vehicle (EV) brand view their vehicles as the 'future of EVs,' associating them with innovation and fashion. Users may be more likely to adopt blockchain technology for VAT refunds owing to its novelty and widespread adoption in advertising. We propose the following hypothesis. H8: IMG has a positive impact on PEU.

2.3.6 Job Relevance (JOR)

According to Venkatesh and Davis (2000, p.191), job relevance refers to an individual's perception of how well a target system aligns with their job responsibilities (Venkatesh & Davis, 2000). It is regarded as a cognitive judgment process that is distinct from the social influence mechanism and directly influences Perceived Usefulness (PU). This concept resembles that of task suitability (Bhattacherjee & Sanford, 2006). Within the VAT refund context, a greater understanding of algorithms and data collection processes based on blockchain technology in tax refunds could lead users to a greater appreciation of the benefits of blockchain applications, thereby enhancing their perception of blockchain's utility for VAT refunds. This may facilitate more efficient data acquisition. Therefore, we propose the following hypothesis:

H9: JOR has a positive impact on PEU

2.3.7 Perceived ease of use (PEOU)

Venkatesh and Davis (2000) define PEOU as the user's perception of the minimal effort, time, or knowledge needed to adopt an Information System (IS). Davis (1989) emphasized PEOU's direct and indirect effects on PEU and intention. Blockchain technology has many limitations, including diverse blockchain systems and established IT infrastructure. Masudin et al. (2021) emphasized PEU because of these constraints. 2021 (Masudin et al.) Tien et al. (2023) found that perceived ease of use (PEU) strongly influences business adoption of social commerce services. This influence includes the adoption of the blockchain technology. Businesses' willingness to use blockchain for VAT refunds is positively correlated with their ease of doing things such as documenting their supply chain and export-import procedures. Thus, the following hypothesis was proposed:

H10: PEOU has a positive impact on IUS

H11: PEOU has a positive impact on PEU

2.3.8 Perceived usefulness (PEU)

According to Davis (1989), PEU is the perceived improvement in task performance when adopting an Information System (IS). PEU expresses users' belief that the new IS will boost productivity and time management. Venkatesh and Davis (2000) claimed that PEU directly affects users' adoption intent, which is crucial to technology acceptance. According to Wang et al. (2022), PEU strongly influences users' intention to advertise. Tew et al. (2021) also found that usefulness strongly influences a business's mobile payment intent. Blockchain-based VAT refund applications improve transparency, automation, compliance, and administrative efficiency (Prasad et al., 2023). According to other blockchain-based technology studies, businesses are more likely to use blockchain for VAT refunds if they consider it beneficial. Thus, the following hypothesis is proposed:

H12: PEU has a positive impact on IUS

2.3.9 Perceived risk (PER)

Perceived Risk (PER) encompasses users' perceptions of uncertainties or potential safety hazards associated with adopting new technologies (Giovanis et al., 2021). In the current investigation, concerns may include the privacy and security of sensitive financial data stored in the blockchain, the possibility of inaccuracies in immutable records, and the complexity of interacting with the technology (H.-B. Nguyen & Nguyen, 2021). Integration difficulties with

existing systems, regulatory compliance issues, and data control uncertainties are perceived as risks. In addition, the possibility of unanticipated costs and disruptions to established processes may affect adoption decisions (Dang et al. 2022). PER's influence of PER on IUS has been demonstrated in several domains, including blockchain (Montecchi et al., 2019), technological devices (Marett et al., 2015), and smart contracts (V. C. Nguyen et al., 2019). Based on the findings of previous studies, the following hypothesis is proposed:

H13: PER has a negative impact effect on IUS

Based on the hypotheses, Figure. 1 depicts our study's research model.

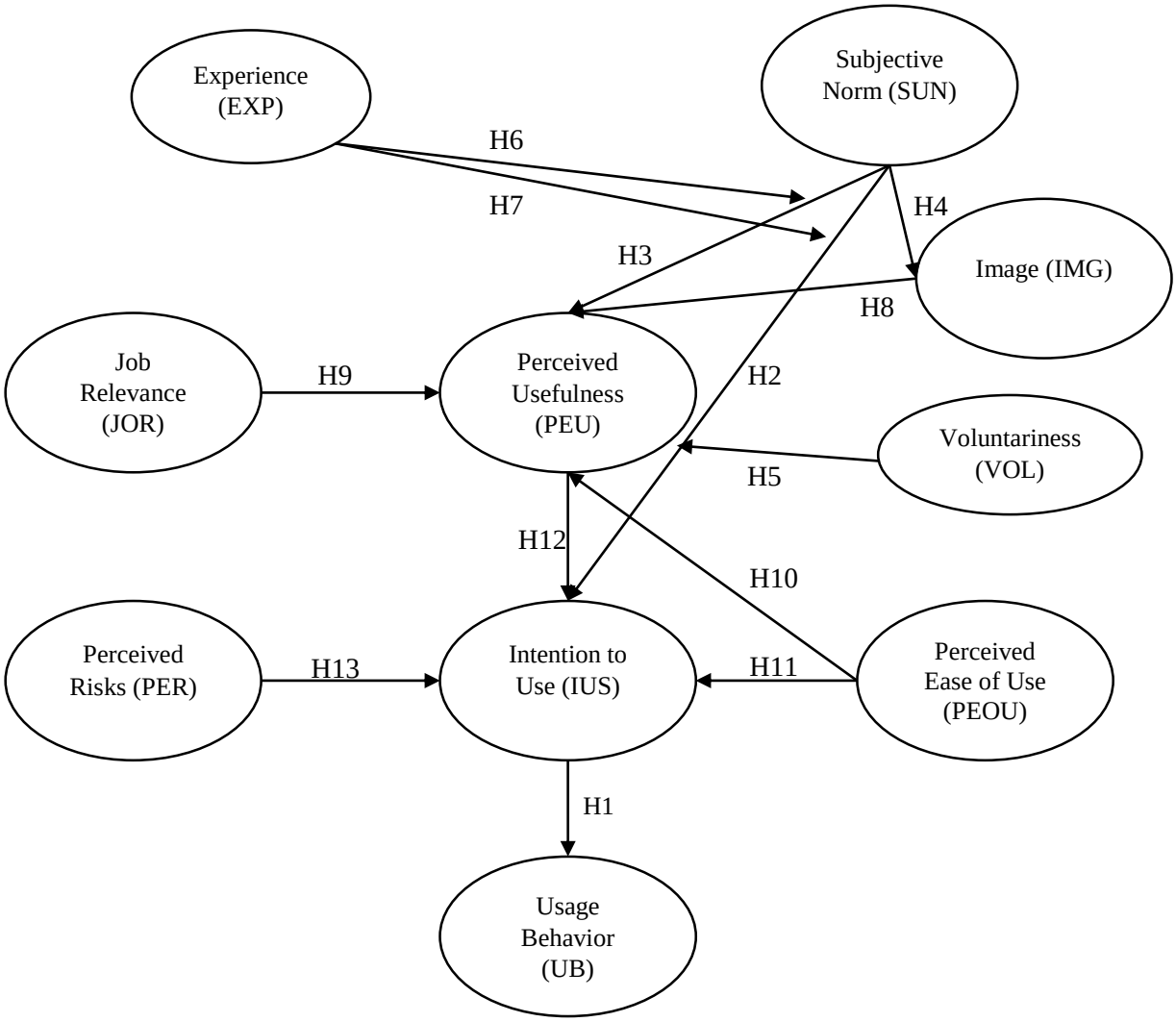

Figure 1. Research model

3. Methodology

The study focused on VAT refund users; therefore, no sampling frame was set. Convenience sampling was used to achieve these research goals. The self-administered questionnaire used established measures from previous research studies to collect data. The survey used a seven-point Likert scale, with "1" for strong disagreement and "7" for strong agreement. This study used previous research's measurement items. SUN, PEOU, PEU, IMG, JOR, VOL, EXP, IUS, and UB are adapted from Sharifzadeh et al. (2017), Venkatesh and Davis (2000), and Wang et al. (2022). PER was created and implemented according to Giovanis et al. (2021).

Online questionnaires improve research methodology (Nguyen et al., 2023). These surveys are practical and efficient for collecting data from a diverse and geographically dispersed participant pool, thus increasing the sample size and research applicability (Brunelle & Grossman, 2022). By eliminating physical materials and manual data entry, this digital approach reduces costs and improves operational efficiency over paper-based surveys (Johnson & Onwuegbuzie, 2004; Nguyen et al., 2023). The adaptability of online surveys allows personalized question sequences based on previous responses, thereby improving data precision and participant engagement. Participants can also provide honest answers to sensitive topics because the online format ensures anonymity and privacy. Real-time data collection, automated data entry simplification analysis, and research design can accommodate different data types. The digital survey was distributed via Facebook and via mail. This application has been shown to be a fast and cost-effective way to obtain a large sample size (Dang et al., 2023; Nguyen, 2023). A panel of three blockchain and tax collection experts validated questionnaire items before data collection. This evaluation led to minor changes in the questionnaire structure, layout, and language. Subsequently, 30 participants participated in a pilot study to test the scale's validity. VAT refund users in Vietnam provided 175 valid responses. This study focuses on Ho Chi Minh City because of its 9.3 million people (Macrotrends, 2023). In 2022, Ho Chi Minh City had 101.58 billion USD in trade volume, outperforming other urban areas (Glotrans, 2022). this sample size is comparable to prior studies in technology adoption and blockchain research (e.g., Wong et al., 2021; Hasan et al., 2022). In PLS-SEM analysis, sample size requirements depend on model complexity and minimum path relationships, and a sample exceeding 150 respondents is generally considered sufficient for robust estimations (Hair et al., 2017). Additionally, focusing on Vietnam's VAT refund system is justified due to Vietnam's unique regulatory challenges, including delays in VAT refunds, administrative inefficiencies, and concerns over tax compliance (Viet & Huong, 2023). While blockchain adoption in taxation has been studied in other countries (e.g., Ainsworth et al., 2018; Alkhodre et al., 2019), few studies provide empirical validation specific to VAT refunds in emerging economies. Since VAT refund systems vary across jurisdictions, conducting a multi-country study may not always be feasible, and a focused investigation in Vietnam offers valuable localized insights. The number of valid responses exceeded the minimum sample size of 114, as determined by G*Power (version 3.1.9.2), with a power level of 0.80, alpha value of 0.05, effect size of 0.15, and nine predictors. The demographic profiles of the participants are presented in Table 1. The results showed that 36.00% of the participants were male and 64.00% were female. The age distribution showed that 70.86% of participants were between 26 and 35, 23.43 percent were between 36 and 50, and fewer were younger or older. A total of 82.29% had graduate degrees, 15.43% had doctorates, and 2.29 percent had only high school diplomas. The participants comprised 11.43 percent sole proprietorships, 37.14 percent private corporations, 22.29 percent public corporations, and 29.14 percent other business structures. Companies varied in size from fewer than 50 workers (57.14%) to 50 to 200 workers (25.71%) to 200 or more workers (17.14%). One-tenth had less than six months of experience, 25.71 percent 1-2 years, 47.43 percent 2.1-5 years, and 17.14 percent over five years. This demographic breakdown helps us understand the participants of the study and contextualize its findings.

4. Data analysis

4.1 Statistical analysis

Partial Least Squares Structural Equation Modeling (PLS-SEM) and Artificial Neural Network (ANN) techniques were used in a two-stage process to analyze the gathered data (Lee et al., 2023). Because of its variance-based nature, PLS-SEM may miss nonlinear relationships, so ANN analysis was performed (H.-B. Nguyen & Nguyen, 2021). According to Lim et al. (2021), an ANN can identify relationships without a deep understanding of the variable correlations. However, an ANN is a 'black box' and may not be suitable for parametric hypothesis testing (Lim et al., 2021). The PLS-SEM-ANN hybrid method overcomes the drawbacks of both the methods and provides a more complete research analysis.

4.2 Common method biases

The potential for common method bias (CMB) exists because the data for independent and dependent variables come from the same place and time (Podsakoff et al., 2003). To address this issue, a combined statistical and operational strategy was used. First, there was an emphasis on encouraging truthfulness by making it clear to survey takers that there was no "wrong" answer. The participants were also guaranteed complete confidentiality of their responses. Harman's single-factor test was used to evaluate possible CMB, similar to the method used by Nguyen et al. (2022) (D. T. V. Dang et al., 2022; B.-T. H. Nguyen, Le, et al., 2023). The findings showed that only 27.3% of the variation can be attributed to a single factor. Because this number is less than half, the CMB is not likely to have a significant impact on the data.

4.3 Assessing the outer measurement model

Table 2 presents the evaluation of data reliability. Dijkstra-Henseler's rho (rho_A), composite reliability (CR), average variance extracted (AVE), and outer loading values all surpassed the predetermined thresholds of 0.70, 0.7, 0.50, and 0.70, respectively. The confirmation of convergent validity in the collected data is consistent with previous research findings (Hair et al., 2017). Furthermore, Table 3 demonstrates that specific heterotrait-monotrait (HTMT) values on latent constructs fall below the most rigorous threshold (HTMT 0.90), thereby indicating the absence of collinearity concerns (Henseler et al., 2014; Lim et al., 2021) and affirming the discriminant validity of the collected data (Wong et al., 2022).

Table 1. Demographic characteristics (N=175)

Demographic characteristics		**Frequency**	**Percentage (%)**
Gender	Male	63	36.00
	Female	112	64.00
Age	18-25 years	7	4.00
	26-35 years	124	70.86
	36-50 years	41	23.43
	Above 50 years	3	1.71
Education background	Diploma level	4	2.29
	Bachelor's degree level	144	82.29
	Postgraduate level	27	15.43
Type of entity	Sole proprietorship	20	11.43
	Private company	65	37.14
	Public company	39	22.29
	Others	51	29.14
Number of employees (i.e. firm size)	Less than 50	100	57.14
	50-200	45	25.71
	More than 200	30	17.14
Experiences in VAT refunds	Less than 6 months	17	9.71
	1-2 years	45	25.71
	2.1 years-5 years	83	47.43
	Above 5 years	30	17.14

Table 2. Loadings, Dijkstra-Henseler's rho, composite reliability and average variance extracted.

Constructs	**Items**	**Loading**	**Cronbach's alpha**	**rho_A**	**composite reliability (CR)**	**Average variance extracted (AVE)**
IMG	IMG1	0.907	0.935	0.948	0.951	0.794
	IMG2	0.901				
	IMG3	0.923				
	IMG4	0.918				
	IMG5	0.799				
IUS	IUS1	0.927	0.927	0.928	0.948	0.821
	IUS2	0.922				
	IUS3	0.891				
	IUS4	0.884				
JOR	JOR1	0.864	0.838	0.846	0.892	0.675
	JOR2	0.830				
	JOR3	0.842				
	JOR4	0.746				
PEOU	PEOU1	0.887	0.862	0.863	0.916	0.783
	PEOU2	0.895				
	PEOU3	0.873				
PER	PER1	0.878	0.882	0.885	0.919	0.739
	PER2	0.874				
	PER3	0.879				
	PER4	0.807				
PEU	PEU1	0.831	0.809	0.813	0.887	0.724
	PEU2	0.835				
	PEU3	0.885				
SUN	SUN1	0.780	0.852	0.853	0.900	0.693
	SUN2	0.857				
	SUN3	0.859				
	SUN4	0.831				
UB	UB1	0.927	0.891	0.899	0.932	0.821
	UB2	0.882				
	UB3	0.908				
VOL	VOL1	0.886	0.827	0.844	0.897	0.744
	VOL2	0.909				
	VOL3	0.787				
EXP	EXP1	1.000				

Table 3. Hetero-trait-mono-trait result ($HTMT^{0.90}$).

	EXP	**IMG**	**IUS**	**JOR**	**PEOU**	**PER**	**PEU**	**SUN**	**UB**
EXP									
IMG	0.512								
IUS	0.579	0.812							
JOR	0.830	0.861	0.861						
PEOU	0.651	0.560	0.563	0.631					
PER	0.570	0.722	0.735	0.803	0.662				
PEU	0.571	0.808	0.776	0.832	0.655	0.779			
SUN	0.447	0.464	0.545	0.557	0.610	0.579	0.539		
UB	0.756	0.785	0.845	0.885	0.752	0.810	0.764	0.546	
VOL	0.548	0.849	0.842	0.828	0.620	0.769	0.810	0.521	0.822

4.4 Inspecting the inner structural model

The bias-corrected and accelerated (BCa) bootstrapping method was used with 5000 subsamples and a two-tailed p-value of 0.05 to identify significant path coefficients in the inner structural model (T. Q. Dang, Tan, et al., 2023). As shown in Table 4 and Figure 2, H3 and H10 did not receive support among the tested hypotheses. IUS ($\beta = 0.773$, $p< 0.001$) displayed a robust and positive correlation with UB, validating Hypothesis 1. Moreover, SUN ($\beta = 0.131$, $p<0.05$), PEU ($\beta = 0.378$, $p<0.001$), and PER ($\beta = 0.329$, $p<0.01$) all demonstrated positive associations with IUS, confirming the validity of Hypotheses H2, H12, and H13. Notably, IMG ($\beta = 0.377$, $p<0.001$), JOR ($\beta = 0.270$, $p<0.001$), and PEOU ($\beta = 0.179$, $p<0.01$) had significant and positive effects on PEU, thus supporting Hypotheses 8, 9, and 11. Finally, the significant positive influence of SUN on IMG ($\beta = 0.419$, $p<0.001$) supports Hypothesis 4. Finally, Table 6 shows that the model effectively explains 50.9% of the overall variance in the UB. In addition, PEU, PER, and SUN accounted for 49.5% of the variations in IUS, whereas JOR, IMG, and PEOU accounted for 44.9% of the variations in PEU, and SUN alone accounted for 15.3% of the variations in IMG.

Table 4. Structural model examination outcome

Hypothesis	Path	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Remark
H1	IUS -> UB	0.773	0.775	0.031	25.114	0.000	Supported
H2	SUN -> IUS	0.131	0.135	0.059	2.240	0.025	Supported
H3	SUN -> PEU	0.069	0.070	0.037	1.836	0.066	Not supported
H4	SUN -> IMG	0.419	0.425	0.071	5.901	0.000	Supported
H8	IMG -> PEU	0.377	0.378	0.066	5.706	0.000	Supported
H9	JOR -> PEU	0.270	0.269	0.074	3.664	0.000	Supported
H10	PEOU -> IUS	0.039	0.040	0.076	0.506	0.613	Not supported
H11	PEOU -> PEU	0.179	0.180	0.054	3.311	0.001	Supported
H12	PEU -> IUS	0.378	0.381	0.080	4.734	0.000	Supported
H13	PER -> IUS	0.329	0.324	0.106	3.103	0.002	Supported

Remarks: *p < 0.05; **p < 0.01; ***p < 0.001

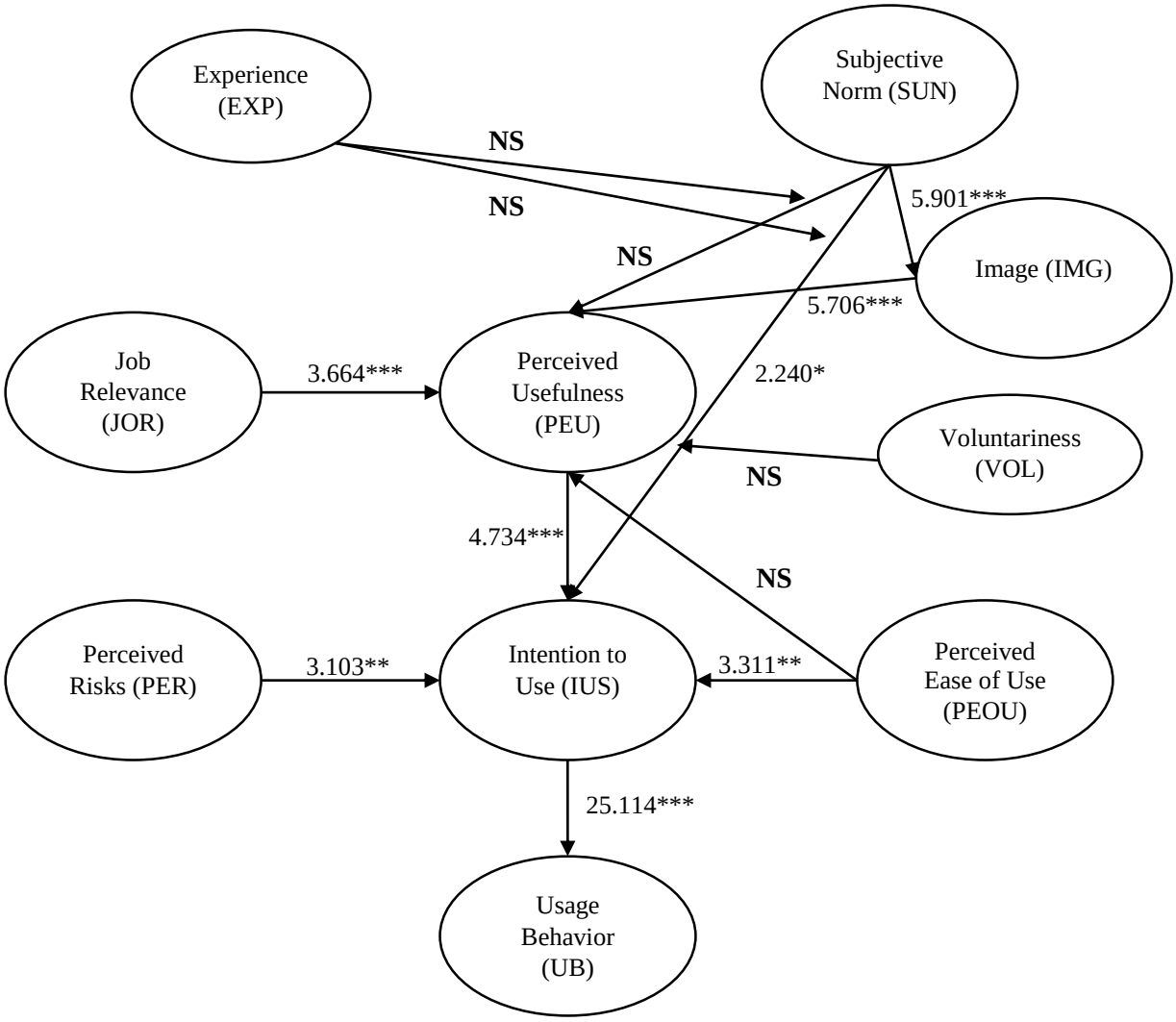

Figure 2. Result of hypothesis testing

4.5 Assessing the moderating effects

Moderated PLS-SEM was used to investigate the potential moderating roles of EXP and VOL in this investigation. According to the results presented in Table 5, neither EXP nor VOL moderated the relationship between SUN and IUS. In addition, the investigation revealed that EXP did not moderate the relationship between SUN and PEU. As a result, H5, H6, and H7 were all disproven. These results suggest that the effect of business SUN on PEU and IUS is relatively stable, regardless of experience level. Similarly, variations in businesses' willingness to volunteer do not result in significant tendencies to view SUN as an influential factor that influences the propensity to embrace blockchain in VAT refunds.

Table 5. Hypothesis testing for moderating effect

Hypotheses	Path	Original sample (O)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Remark
H5	VOL x SUN -> IUS	0.094	0.052	1.816	0.069	Not supported
H6	EXP x SUN -> IUS	-0.058	0.054	1.079	0.281	Not supported
H7	EXP x SUN -> PEU	0.006	0.023	0.264	0.792	Not supported

4.6 Predictive relevance, effect size, and PLS-Predict

Table 6 shows that all Stone–Geisser's cross-validated redundancy Q2 values are above zero, indicating predictive significance (Cohen, 2013). The magnitude of the associations between the variables was measured using f2 (Cohen, 2013). Effect sizes of 0.02, 0.15, and 0.35 indicate small, medium, and significant effects, respectively. Table 7 shows that IMG implementation has little effect on PEU. Perceived ease of use (PEU) moderately affects intention to use (IUS), whereas perceived enjoyment (PER) has little effect on game motivation. However, the alternative pathways had little or no effect. According to Lew et al. (2020), R2 is important for assessing a model's ability to explain data within a sample. Therefore, the predictive performance of the Partial Least Squares (PLS) technique was used to evaluate its effectiveness in out-of-sample scenarios. Table 8 shows that the UB has a good Q2 prediction. The root mean squared error (RMSE) values from partial least squares structural equation modeling (PLS-SEM) do not exceed the linear model benchmark (Duc et al., 2024; Phan et al., 2025). This suggests that the model could provide a good prediction.

Table 6. Predictive relevance, Q^2

	Q^2 predict	RMSE	MAE	R-square
IMG	0.153	0.928	0.717	0.179
IUS	0.495	0.719	0.513	0.664
PEU	0.449	0.748	0.566	0.530
UB	0.509	0.707	0.569	0.598

Table 7. Effect size (f^2).

	IMG	IUS	JOR	PEOU	PER	PEU	SUN	UB
IMG						0.135		
IUS								1.485
JOR						0.065		
PEOU		0.002				0.046		
PER		0.116						
PEU		0.167						
SUN	0.213	0.025				0.008		
UB								

Table 8. PLS predict result

	Q^2 predict	PLS-SEM_RMSE	PLS-SEM_MAE	LM_RMSE	LM_MAE
IMG1	0.159	0.869	0.634	1.088	0.843
IMG2	0.113	0.841	0.635	1.084	0.857
IMG3	0.135	0.891	0.618	1.148	0.907
IMG4	0.145	0.900	0.641	1.187	0.955
IMG5	0.057	1.057	0.734	1.312	1.010
IUS1	0.428	0.886	0.616	0.924	0.687
IUS2	0.372	0.981	0.709	1.061	0.809

Table 8. PLS predict result (*Continued*)

IUS3	0.389	0.925	0.631	0.957	0.695
IUS4	0.432	0.848	0.617	0.928	0.715
PEU1	0.272	1.208	0.891	1.253	0.971
PEU2	0.375	0.950	0.691	0.967	0.748
PEU3	0.330	1.024	0.734	1.084	0.809
UB1	0.431	0.642	0.451	0.764	0.613
UB2	0.367	0.829	0.556	0.879	0.678
UB3	0.449	0.712	0.497	0.792	0.629

4.7 Importance performance map analysis

The purpose of Importance Performance Map Analysis (IPMA) is to identify constructs that are highly significant in relation to the targeted variables but exhibit suboptimal performance (A. H. D. Nguyen et al., 2024; N. T. T. Nguyen et al., 2024). The IPMA results for the UB are shown in Table 9 and Figure 3. Among the constructs, IUS had the greatest influence on UB (0.773), followed by PEU (0.292) and PER (0.254). In contrast, SUN (86.832) demonstrated the best performance, followed by PEOU (84.213), and PER (79.217). Emphasis should be placed on IUS when it has a high effect but poor performance.

Table 9. Importance performance map results.

	Importance (Total Effect)	Performance (Index Value)
IMG	0.110	77.130
IUS	0.773	78.301
JOR	0.079	77.839
PEOU	0.082	84.213
PER	0.254	79.217
PEU	0.292	76.246
SUN	0.168	86.832
Means	**0.251**	**79.968**

4.8 Artificial neural networking (ANN) analysis

In business research, Artificial Neural Networks (ANNs) simulate human cognitive processes and task performance (Lau et al., 2021). When making dependent variable predictions using complex inputs, artificial neural networks (ANNs) resist collinear independent variables and do not require linearity assumptions (Lim et al., 2021). This study trains the dataset and evaluates the predictor importance using feed-forward-back-propagation (FFBP) with a multilayer perceptron (MLP). The dataset was divided into ten equal subsets for a 10-fold cross-validation (B.-H. T. Nguyen et al., 2024; L.-T. Nguyen et al., 2024). The strategy uses 90% of the data for training and 10% for testing. Addressing overfitting is the primary goal of this approach. SPSS 25 automatically generated the hidden and output layers of the ANN model by using sigmoid activation. Tables 10 and 11 use the RMSE values to validate the predictive accuracy. All ANN models had low RMSEs, indicating high predictive accuracy. The predictive power of the ANNs is presented in Table 12. Normalized importance, calculated by dividing each predictor's relative importance by the highest relative importance within each ANN model, was used to assess the effects of the predictors on PEU and IUS (Lee et al., 2020). IMG predicts PEU the best, followed by JOR and PEOU. PEU predicts IUS the best, followed by

PER and SUN. Figures 4 and 5 show the two ANN models used for the sensitivity analysis. Table 13 presents the significant predictors of the research model. PLS-SEM ranks by path coefficients, whereas ANN models rank by normalized relative importance. Notably, ANN rankings and PLS-SEM have the same ranking factors, improving research validity, reliability, and generalizability and enabling a more thorough and robust interpretation. Rank consistency across methodologies improves theoretical understanding of variable relationships (Lee et al., 2021). This solid foundation allows researchers to confidently draw theoretical and practical conclusions (Lee et al., 2023).

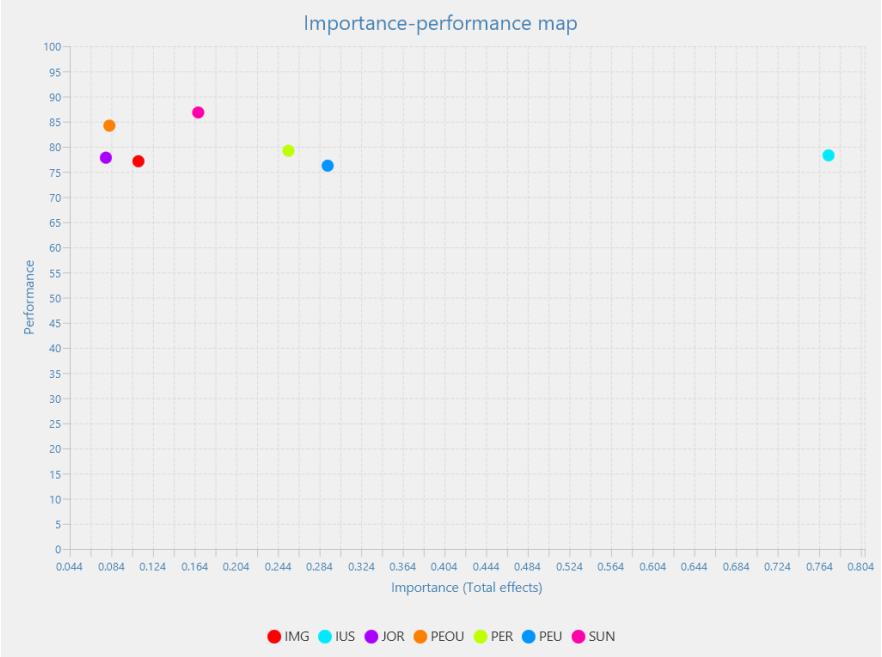

Figure 3. IPMA for UB

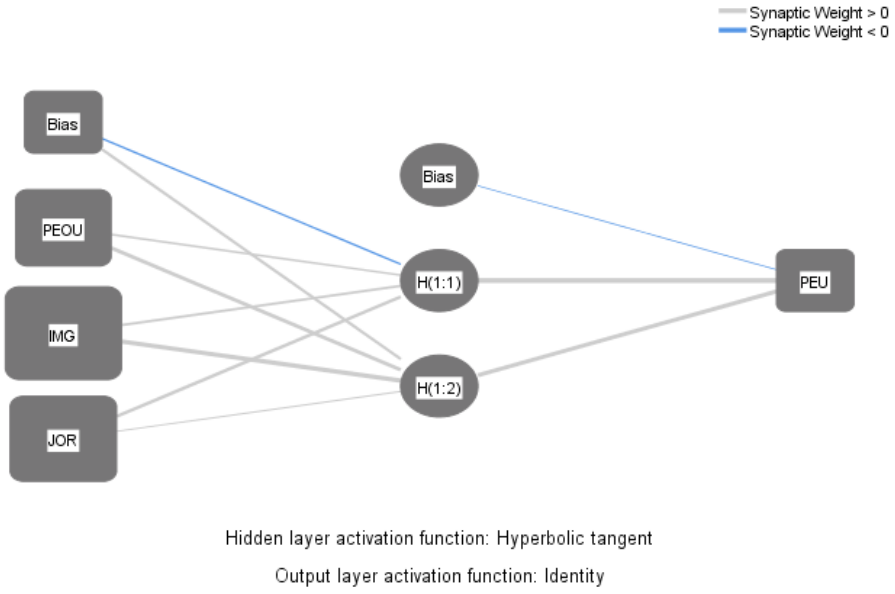

Figure 4. ANN model A for PEU

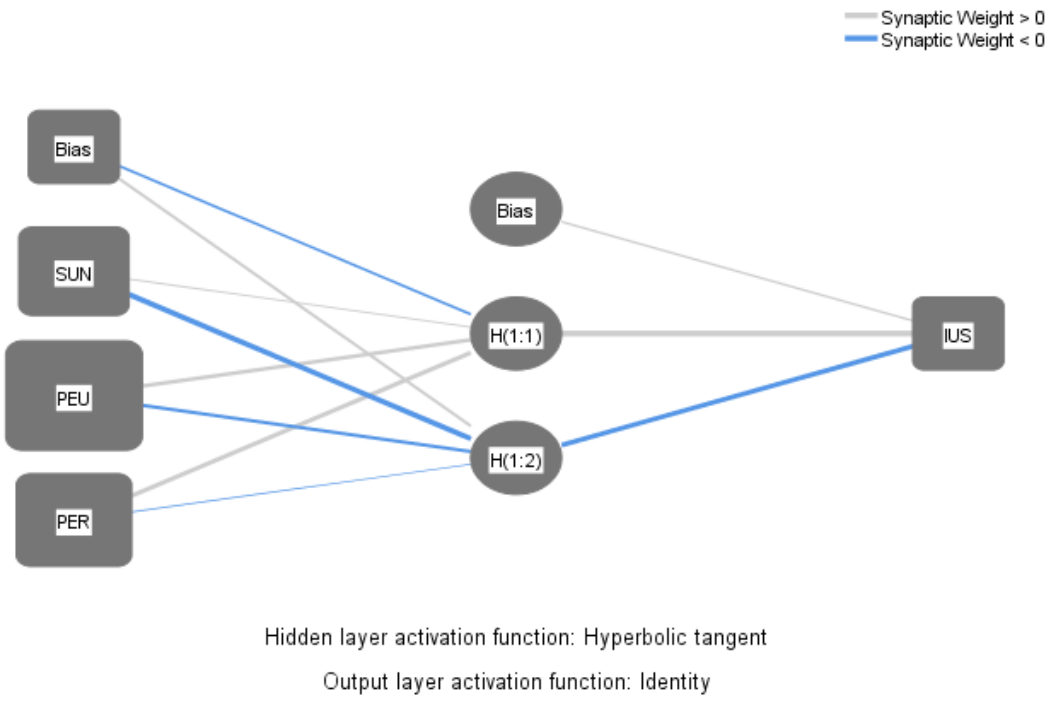

Figure 5. ANN model B for IUS

Table 10. RMSE value of ANN model A

Neural Network	Model A: Input IMG, JOR, PEOU and Output is PEU					
		TRAINING			TESTING	
	N	SSE	RMSE	N	SSE	RMSE
ANN1	154	156.232	0.416	21	21.981	0.381
ANN2	159	193.662	0.560	16	16.091	0.313
ANN3	156	187.097	0.506	19	19.250	0.526
ANN4	155	178.957	0.587	20	21.167	0.550
ANN5	157	172.951	0.503	18	16.754	0.389
ANN6	159	167.166	0.478	16	14.734	0.438
ANN7	156	165.679	0.442	19	20.752	0.474
ANN8	157	177.369	0.490	18	15.222	0.333
ANN9	155	182.620	0.529	20	24.126	0.650
ANN10	158	184.917	0.519	17	17.628	0.353
Means		176.665	0.503		18.771	0.441
SD		10.720	0.048		3.005	0.103

Table 11. RMSE value of ANN model B

Neural Network	Model B: Input SUN, PEU, PER and Output is IUS					
		TRAINING			TESTING	
	N	SSE	RMSE	N	SSE	RMSE
ANN1	158	147.030	0.380	17	14.731	0.294
ANN2	151	163.834	0.517	24	20.524	0.250
ANN3	159	156.483	0.403	16	13.703	0.313
ANN4	152	151.494	0.447	23	20.176	0.261
ANN5	153	139.729	0.386	22	20.055	0.318
ANN6	164	159.051	0.390	11	7.588	0.182
ANN7	152	169.561	0.566	23	21.064	0.435
ANN8	156	144.846	0.385	19	19.818	0.421
ANN9	151	161.366	0.457	24	23.726	0.375
ANN10	159	149.779	0.403	16	9.899	0.188
Means		154.317	0.433		17.128	0.304
SD		8.854	0.060		5.064	0.083

Table 12. Sensitivity analysis of Model A and Model B

Neural Network	Model A: Input IMG, JOR, PEOU and Output is PEU			Model B: Input SUN, PEU, PER and Output is IUS		
	IMG	JOR	PEOU	SUN	PEU	PER
1	0.447	0.252	0.301	0.298	0.403	0.299
2	0.398	0.388	0.214	0.272	0.404	0.324
3	0.338	0.325	0.337	0.367	0.361	0.272
4	0.475	0.272	0.253	0.286	0.338	0.376
5	0.447	0.269	0.284	0.278	0.399	0.323
6	0.497	0.24	0.263	0.327	0.384	0.289
7	0.408	0.307	0.285	0.235	0.358	0.407
8	0.495	0.314	0.191	0.283	0.372	0.345
9	0.354	0.398	0.248	0.242	0.407	0.351
10	0.273	0.392	0.335	0.285	0.421	0.294
Average relative importance	0.413	0.316	0.271	0.287	0.385	0.328
Normalized relative importance (%)	100.00%	87.50%	73.20%	71.20%	100.00%	76.90%

Table 13. PLS-SEN and ANN results comparison.

PLS path	Original sample	ANN results	PLS-SEM ranking	ANN ranking	Remark
Mode A					
IMG->PEU	0.377	100.00%	1	1	Matched
JOR->PEU	0.27	87.50%	2	2	Matched
PEOU->PEU	0.179	73.20%	3	3	Matched
Model B					
SUN-> IUS	0.131	71.20%	3	3	Matched
PEU->IUS	0.378	100.00%	1	1	Matched
PER->IUS	0.329	76.90%	2	2	Matched

5. Discussions, Implications, Conclusions, Limitations, and Recommendations

5.1 Discussions

This study examines the antecedents of blockchain VAT refund acceptance. IUS and UB were significantly related, supporting H1. Hyvärinen et al. (2017) suggest that businesses may value it for streamlined refund procedures, reduced paperwork, faster processing, and increased transparency. This result supports that of Tan et al. (2010), who found a strong correlation between IUS and UB. H2 supports a significant relationship between SUN and IUS, which agrees with Nguyen et al. (2023), who found that social networks positively affect users' blockchain adoption rooted in peer opinions. SUN also had a significant and positive relationship with IMG, supporting H4 and Khan and Sukhotu (2020), who found that positive influences from others improve self-image. IMG, JOR, and PEOU positively affected PEU, supporting H8, H9, and H11. These findings are consistent with those of Alwabel and Zeng (2021), Bhattacherjee and Sanford (2006), and Tien et al. (2023). Positive and significant relationships between PEU and IUS and PER and IUS support H12 and H13. These findings are supported by Luarn and Lin (2005), Tan et al. (2010), and Zhong et al. (2021). Nguyen et al. (2019) and Marett et al. (2015) found no correlation between PER and IUS (Marett et al. 2015; H.-B. Nguyen & Nguyen, 2021). However, this result is inconsistent. The paradoxical positive effect of perceived risk on blockchain implementation for VAT refunds has several causes. This unexpected correlation may be due to users' increased awareness of potential dangers, which has made them more cautious and vigilant about technology. Users may actively participate in and understand technology to secure financial transactions, such as VAT refunds, owing to its perceived importance. The positive correlation also suggests confidence in the technology's risk management capabilities, thus reducing anxiety (Montecchi et al., 2019). Users' cautious and controlled adoption of and adaptability to technology requirements may increase their acceptance. This relationship may also reflect a learning process in which users become familiar with the technology and realize that its benefits outweigh their initial concerns. Contrary to expectations, this positive relationship shows the complex relationship between perceived risk and technology adoption in blockchain VAT refund implementations.

The unsupported moderating effects of voluntariness (H5) and experience (H6, H7) suggest that in the context of blockchain-based VAT refunds, adoption decisions and usability perceptions are shaped more by regulatory requirements and technical factors rather than social influence or personal discretion. The lack of support for H5 implies that voluntariness does not significantly alter the relationship between subjective norms (SUN) and intention to use (IUS), likely because businesses perceive blockchain adoption in VAT refunds as mandatory rather than discretionary. Even if peers endorse the system, firms may adopt it primarily due to compliance obligations rather than social persuasion. Similarly, H6 and H7 indicate that experience does not moderate the effects of subjective norms on either intention to use or perceived ease of use (PEU). This may be attributed to the institutional and technical nature of blockchain adoption, where even experienced users make decisions based on regulatory frameworks and system design rather than peer influence. Additionally, the inherent complexity of blockchain technology may mean that ease of use is assessed based on formal training, official documentation, and system usability rather than subjective opinions from others.

The lack of a significant relationship between subjective norms (SUN) and perceived ease of use (PEU) (H3) and between perceived ease of use (PEOU) and intention to use (IUS) (H10) contradicts the findings of Venkatesh and Davis (2000), who demonstrated strong positive associations between these constructs in workplace technology adoption. One possible explanation for the unsupported H3 is that blockchain technology, particularly in the context of VAT refunds, is inherently complex and technical. Unlike conventional workplace technologies, blockchain adoption may rely more on system training, regulatory mandates, and organizational policies rather than social influence. Even if peers endorse the system, this does not necessarily make it easier to use, as usability depends on technical proficiency and system design rather than subjective opinions. Similarly, the unsupported H10 suggests that ease of use is not a strong determinant of blockchain adoption intention in this context. Unlike consumer-oriented technologies where usability significantly affects adoption decisions, businesses implementing blockchain for VAT refunds may prioritize security, compliance, and transparency over ease of use. For example, financial institutions and tax professionals may be willing to adopt a complex system if it ensures fraud prevention and regulatory compliance, even if it is not intuitively easy to use. This finding aligns with prior research suggesting that in enterprise and regulatory environments, factors such as trust, data security, and legal compliance often outweigh ease of use in driving adoption decisions (Wang et al., 2022). Therefore, while Venkatesh and Davis (2000) found significant relationships in workplace technology acceptance, blockchain's unique characteristics and regulatory implications in taxation create a different adoption context where usability is less influential.

5.2 Implications

By integrating the Technology Acceptance Model 2 (TAM2) with blockchain adoption in VAT refunds, an area that remains relatively unexplored in taxation and blockchain research, this study advances the theoretical understanding of blockchain implementation in financial processes. A key contribution of this research is the introduction of Perceived Privacy Risk (PER) as a novel variable within the TAM2 framework, building upon prior studies on blockchain technology acceptance and privacy concerns (L.-T. Nguyen, Nguyen, et al., 2023; Tien et al., 2023; Wong et al., 2020). Given that blockchain systems utilize encryption and tamper-resistant records, privacy concerns play a critical role in shaping perceptions of security and reliability. Future research can leverage PER in the context of blockchain and taxation to examine how varying privacy expectations influence consumer decision-making regarding emerging blockchain technologies, particularly in the presence of linear and nonlinear adoption patterns. Furthermore, this study enhances the TAM2 framework by integrating external factors and societal norms, offering a more comprehensive perspective on how individual intentions and usage behaviors shape blockchain adoption. By addressing the knowledge gap in VAT refund adoption, this research provides empirical insights that inform both academia and industry, while also establishing a foundation for future studies on blockchain applications in taxation. The findings contribute to the broader discourse on technology adoption in financial services, facilitating market expansion in both emerging and developed economies.

The findings of this study offer valuable managerial implications for tax authorities, blockchain enterprises, and policymakers seeking to enhance the adoption of blockchain-based VAT refund systems. To ensure successful integration, privacy and data security must be prioritized, as they play a crucial role in fostering trust and acceptance among users. The traceability of blockchain technology can enhance compliance visibility, thereby improving transparency and reducing the risk of fraudulent activities. Encouraging user acceptance requires effective communication of streamlined processes, minimizing administrative burdens, and demonstrating the efficiency gains of blockchain adoption. Additionally, acknowledging social norms can help businesses enhance their reputation and encourage broader adoption. Aligning blockchain technology with job roles and providing comprehensive training programs can facilitate employee adaptation to new systems. Furthermore, clear communication strategies and robust security measures can mitigate user concerns, reducing perceived risks and increasing confidence in blockchain-based solutions. To ensure long-term adoption, continuous education, support mechanisms, and iterative improvements are essential. These insights offer a strategic roadmap for stakeholders navigating the complexities of blockchain implementation in taxation.

5.3 Conclusions

In conclusion, this study provides important insights into the business acceptance of blockchain technology in the context of Value-Added-Tax (VAT) funds. By integrating Technology Acceptance Model 2 (TAM2) with blockchain acceptance, this study illuminates the complex interplay of the factors influencing individuals' intentions to adopt blockchain-based tax solutions. The empirical findings highlight the significance of factors such as perceived usefulness, perceived ease of use, subjective norms, image, job relevance, and perceived risk in determining user

attitudes and behaviors regarding the adoption of blockchain technology for VAT refunds. This study establishes the significance of multiple constructs and their linear and nonlinear effects on user acceptance of this innovative technology through a comprehensive analysis that employs a two-stage approach.

5.4 Limitations and Recommendations

Nevertheless, it is imperative to recognize the limitations of this study. The study's geographical focus on Vietnam presents a potential limitation in terms of generalizability, as taxation policies, socioeconomic conditions, and regulatory frameworks vary across countries (Maleki et al., 2024; Siddiqui et al., 2024). While Vietnam provides an insightful case study, future research should explore broader regional and international contexts to assess whether blockchain adoption for VAT refunds exhibits similar drivers and barriers in different jurisdictions. Additionally, the study primarily examines business users' perspectives, potentially overlooking the viewpoints of tax authorities, regulators, and policymakers, who play a crucial role in the adoption and implementation of blockchain-based tax solutions. A more comprehensive approach incorporating multi-stakeholder perspectives could provide deeper insights into the practical feasibility and regulatory considerations of blockchain adoption in taxation. The use of cross-sectional data further limits the ability to establish causal relationships between variables (KARAOULANIS, 2024). While PLS-SEM and ANN offer robust analytical capabilities, a longitudinal study would help capture the evolution of blockchain adoption over time, providing stronger causal inferences. Moreover, the study's specific focus on VAT refunds highlights a critical but narrow aspect of blockchain adoption in taxation. Given blockchain's potential for enhancing compliance, reducing fraud, and streamlining processes in various tax domains, future research should explore its application in other taxation areas, such as corporate tax, personal income tax, and customs duties. These limitations do not diminish the study's value but highlight areas where further investigation is needed. Expanding the research scope to include different geographical settings, diverse stakeholder perspectives, and longitudinal methodologies would strengthen the applicability and impact of blockchain-based taxation research (Liu, 2025).

Data Availability

Data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors report there are no competing interests to declare.

Ethical Compliance

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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