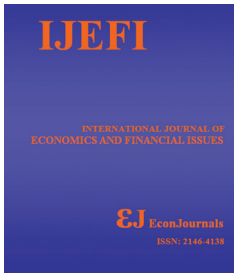


International Journal of Economics and Financial Issues

ISSN: 2146-4138

available at http: www.econjournals.com

International Journal of Economics and Financial Issues, 2025, 15(6), 119-129.

Analyzing Determinants of Tax Management Effectiveness in Transportation Construction Enterprises in Vietnam: A Hybrid SEM–ANN Approach

Ngo Thi Huong[1], Vuong Thi Bach Tuyet[1], Hoang Thi Hong Le[1], Quang Hung Do[2]*

[1]University of Transport Technology, Hanoi, Vietnam, [2]Fintech Lab, Posts and Telecommunications Institute of Technology (PTIT), Hanoi, Vietnam. *Email: dqhung@ptit.edu.vn

Received: 26 April 2025 **Accepted:** 07 September 2025 **DOI:** https://doi.org/10.32479/ijefi.20562

ABSTRACT

This study investigates the key determinants influencing tax management effectiveness among transportation construction enterprises in Vietnam. Drawing upon the Institutional Theory, Theory of Planned Behavior, and Technology Acceptance Model, a conceptual framework was developed incorporating six factors: Tax Policy, Tax Officers, Infrastructure for Tax Administration, Corporate Tax Compliance Awareness, Digital Technology, and Tax Administration Functions. Data were collected from 385 firms using structured questionnaires. A hybrid methodological approach combining Structural Equation Modeling (SEM) and Artificial Neural Networks (ANN) was employed to capture both linear and nonlinear relationships among constructs. SEM results revealed that all six factors significantly influence tax management effectiveness, with Tax Policy and Tax Officers being the most impactful. The ANN analysis further confirmed these findings and ranked variable importance, highlighting Tax Policy as the strongest predictor. The study offers practical implications for policymakers aiming to enhance tax governance in project-based, capital-intensive sectors and demonstrates the value of hybrid modeling in public finance research.

Keywords: Tax Management Effectiveness, Transportation Construction, Structural Equation Modeling, Artificial Neural Network, Tax Policy, Public Finance
JEL Classifications: H20; H26; H83

1. INTRODUCTION

The transportation construction sector plays a critical role in supporting urban development and economic growth, particularly in emerging economies like Vietnam. In Hanoi, the capital city undergoing rapid urbanization, a large number of infrastructure projects are commissioned annually, often involving substantial investments and multi-party participation (Ministry of Construction, 2024). However, the tax management of construction enterprises in this domain remains a challenge due to the industry's unique characteristics, such as mobile construction sites, subcontracting networks, varying project durations, and complex cost structures. Inefficiencies in tax collection and monitoring lead to revenue losses, compliance gaps, and weakened public trust. The situation is further complicated by the limited integration of digital technologies and inconsistent coordination between tax authorities and businesses. Despite various regulatory efforts, there is still a lack of empirical understanding of the key factors that influence the effectiveness of tax administration in the construction sector (Hong, 2022; Shukla et al., 2011a). However, while SEM–ANN has been applied in areas such as individual tax compliance, income tax fraud detection, and digital tax systems (Hayat et al., 2022; Rosid, 2022; Shi et al., 2023), few empirical studies have explored its application within the construction sector—especially in project-based, capital-intensive contexts like transportation construction in Vietnam. Given the unique

operational characteristics and tax complexities in this sector, there remains a notable research gap regarding the combined use of SEM and ANN to assess determinants of tax management effectiveness. This study addresses that gap by developing and validating a hybrid SEM–ANN model specifically tailored to transportation construction enterprises in Hanoi, Vietnam.

While previous studies on tax compliance have primarily relied on traditional linear modeling methods such as Structural Equation Modeling (SEM), recent advancements in hybrid analytical techniques offer enhanced capabilities to uncover complex, nonlinear relationships. The combination of SEM and Artificial Neural Networks (ANN), often referred to as the SEM–ANN approach, has been increasingly adopted in tax-related research. This hybrid method leverages SEM's capacity to assess causal relationships among latent constructs and ANN's strength in capturing nonlinear patterns and ranking predictor importance. For example, Hayat et al. (2022) applied a dual-stage PLS-SEM and ANN approach to analyze tax compliance behavior in Malaysia, effectively identifying and prioritizing critical determinants. Similarly, Rosid (2022) used ANN to predict corporate tax payment behavior in Indonesia, demonstrating its added value in modeling nonlinearity. Other studies in diverse contexts (Murorunkwere et al., 2022; Pérez López et al., 2019; Shi et al., 2023), have employed ANN, alone or in combination with SEM, to enhance the detection of tax evasion and compliance risks. These studies collectively confirm that the SEM–ANN framework provides both theoretical and predictive advantages, particularly in contexts with complex behavioral dynamics and regulatory challenges (Bakhshi et al., n.d.; Kodra and Dhamo, 2025; Nam, 2025; Rahman & Hossain, 2025; Sun et al., 2024).

By combining Structural Equation Modeling (SEM) and Artificial Neural Networks (ANN), this study aims to develop a robust, data-driven framework for analyzing the determinants of tax management effectiveness in Hanoi's transportation construction enterprises.

This research seeks to answer the following questions: This research seeks to answer the following questions:

1. What are the main factors affecting the effectiveness of tax management in transportation construction enterprises?
2. How do these factors interact, both linearly and nonlinearly?
3. What are the managerial and policy implications of these findings?

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

2.1. Theoretical Foundation

Effective tax management has increasingly become a focal point in the context of public sector governance and private sector compliance, especially within emerging economies. Tax management, in essence, refers to the administrative and operational activities undertaken by tax authorities and taxpayers to ensure that tax obligations are met efficiently, fairly, and transparently (Bird, 2010). In transition economies like Vietnam, tax management is significantly shaped by the interplay of institutional quality, regulatory frameworks, administrative capabilities, taxpayer behavior, and technological integration (Alm et al., 2016a; Doan et al., 2022)

This study is grounded in several theoretical underpinnings. First, Institutional Theory posits that the structures, rules, and norms within institutions such as tax authorities can significantly influence organizational and individual behavior (Lammers and Barbour, 2006; Scott, 2005; Tina Dacin et al., 2002). In this context, tax policies (TP), tax officers (TO), and administrative infrastructure (ITA) form the institutional scaffolding that determines how efficiently tax systems operate. The clarity, consistency, and industry relevance of tax policies are especially crucial in determining how enterprises interpret and respond to their tax obligations.

Second, the Theory of Planned Behavior (TPB) developed by Ajzen (1991) provides a foundation for understanding taxpayer compliance behavior. According to TPB, individual actions are shaped by attitudes, subjective norms, and perceived behavioral control. Corporate Tax Compliance Awareness (CTCA) reflects firms' understanding of their responsibilities, awareness of enforcement mechanisms, and internal capacity to comply with tax regulations. Higher awareness leads to improved tax behavior, reducing the administrative burden and enhancing overall tax management.

Third, the integration of Technology Acceptance Model (TAM) (Davis, 1989a) highlights the role of perceived usefulness and ease of use of technology in shaping user adoption. As governments transition toward digital tax systems, Digital Technology (DT) becomes a vital determinant of tax management effectiveness. The implementation of e-tax platforms, data synchronization, and IT proficiency of tax officers enables a more efficient, transparent, and accessible tax system.

Finally, effective Tax Administration Functions (TAF)—including processes for registration, declaration, audit, penalty enforcement, and taxpayer communication—are central to the overall success of tax governance (OECD, 2023). The design and delivery of these functions must not only align with legal frameworks but also be adaptable to the unique conditions of sectors like transportation construction, which are often project-based and capital-intensive.

Together, these theoretical perspectives provide a comprehensive framework for understanding the multifaceted determinants of tax management effectiveness, particularly in a localized context such as Hanoi's transportation construction sector.

- Tax Policy (TP): Tax policy serves as the legal and institutional framework that guides tax administration and taxpayer compliance. A well-designed policy must be coherent, aligned with accounting standards, and adaptable to the specific characteristics of the construction sector. According to Bird (2010), clarity and consistency in tax policies reduce compliance costs and enhance voluntary compliance. In transitional economies like Vietnam, the adaptation of tax policies to sector-specific needs is essential for effective tax governance (Shukla et al., 2011b).

- Tax Officers (TO): Human resource capacity within tax authorities is a key enabler of effective tax administration. The professional qualifications, ethical standards, and service orientation of tax officers directly affect taxpayer perceptions and compliance behavior. (Fjeldstad and Moore, 2009) argue that improving the competence and integrity of tax officials strengthens institutional trust and voluntary tax compliance. In the Vietnamese context, combating corruption and enhancing taxpayer services remain top priorities (Painter, 2003; Pham, 2020; Vu and Cao, 2021).
- Infrastructure for Tax Administration (ITA): Infrastructure refers to the physical, technical, and organizational systems supporting tax operations. Adequate infrastructure ensures timely processing of tax activities, efficient internal coordination, and a conducive working environment. Alm et al. (2016a) emphasize that administrative capacity, including IT systems and internal coordination mechanisms, contributes to lowering administrative and compliance costs, which in turn boosts efficiency.
- Corporate Tax Compliance Awareness (CTCA): Awareness and willingness to comply with tax obligations among enterprises are critical for tax management. Theories of planned behavior (Ajzen, 1991) and deterrence theory (Becker, 1968) suggest that awareness of tax responsibilities, combined with perceived enforcement and financial capability, influence compliance behavior. Enterprises with strong financial and digital capacity are more likely to understand, implement, and comply with tax requirements (Kirchler, 2007).
- Digital Technology (DT): The application of digital technology, especially e-taxation, has transformed the tax administration landscape. The Technology Acceptance Model (TAM) posits that perceived usefulness and ease of use influence the adoption of technology (Davis, 1989a). In Vietnam, the Ministry of Finance has emphasized digital transformation as a strategic direction to improve tax services, integrate data, and enhance the responsiveness of tax systems (General Department of Taxation, 2023).
- Tax Administration Functions (TAF): This construct encompasses the operational functions of tax administration, such as registration, declaration, inspection, enforcement, communication, and complaint resolution. The OECD (2019) highlights that efficient execution of these functions enhances transparency and fairness, reduces evasion, and increases taxpayer satisfaction. Moreover, prompt service delivery and robust enforcement mechanisms are vital to fostering voluntary compliance and deterring non-compliance (Torgler, 2005).
- Tax Management (TM): Tax management effectiveness is defined as the extent to which tax authorities achieve their administrative objectives, including timely service delivery, taxpayer satisfaction, transparency, and the prevention of tax evasion. It is both an outcome of internal tax system performance and external taxpayer engagement. The constructs (Table 1) and hypotheses proposed in this study build a comprehensive framework to evaluate and predict tax management effectiveness using a hybrid SEM–ANN approach, allowing for both causal inference and non-linear pattern recognition.

Table 1: Constructs and their items

No	Construct	Item	Instrument
1	Tax Policy (TP)	TP1	Tax policies are clear, consistent, and easy to implement.
2		TP2	Tax policies are aligned with the accounting regulations.
3		TP3	The tax policy system is appropriate for the characteristics of the transportation construction industry.
4	Tax Officers (TO)	TO1	Tax officers possess high professional qualifications.
5		TO2	Tax officers are responsible and provide good service attitude.
6		TO3	There is no corruption or harassment in the performance of tax duties.
7		TO4	The organizational structure is clear, with a reasonable division of responsibilities among tax authorities.
8	Infrastructure for Tax	ITA1	Tax support equipment is sufficient and modern.
9	Administration (ITA)	ITA2	The working environment provides favorable conditions for tax officers.
10		ITA3	There is effective coordination among functional units within the tax authority.
11	Corporate Tax	CTCA1	Enterprises clearly understand their tax responsibilities and obligations.
12	Compliance	CTCA2	There is a high probability of tax inspections.
13	Awareness (CTCA)	CTCA3	The enterprise has strong financial capacity.
14		CTCA4	The enterprise has good IT application skills and capabilities.
15	Digital Technology	DT1	The e-tax declaration system is user-friendly and convenient.
16	(DT)	DT2	Tax data is integrated and synchronized effectively.
17		DT3	Tax officers are proficient in applying IT.
18		DT4	There is an online support system for taxpayers.
19	Tax Administration	TAF1	Tax notifications are complete and timely.
20	Functions (TAF)	TAF2	The processes for tax registration, declaration, payment, refund, exemption, and reduction are appropriate.
21		TAF3	Tax inspections and audits are equipped with adequate tools to detect violations.
22		TAF4	Penalties are sufficiently strict to deter tax violations.
23		TAF5	Tax communication activities help businesses understand their tax obligations.
24		TAF6	Tax complaints are resolved within the prescribed time frame.
25		TAF7	Revenue management methods are effective.
26	Tax Management	TM1	Tax procedures are processed in a timely manner.
27	(TM)	TM2	Enterprises are satisfied with the services provided by tax authorities.
28		TM3	Tax authorities are transparent in providing information.
29		TM4	Tax administration helps prevent tax evasion.
30		TM5	Issued tax policies are responsive to the characteristics of the construction industry.

2.2. Research Hypotheses

Building upon the theoretical foundations discussed, this study proposes six research hypotheses to empirically examine the relationships between selected organizational and technological factors and tax management effectiveness (TM) in transportation construction enterprises.

Tax policy plays a critical role in defining the operating environment for businesses. Clear, consistent, and industry-aligned tax regulations enable enterprises to plan their tax obligations better and reduce ambiguity in tax compliance. Bird (2015) emphasizes that sector-specific considerations in policy design can enhance administrative effectiveness and taxpayer satisfaction. In Vietnam's context, where transportation construction projects often involve complex financial arrangements, the relevance and adaptability of tax policies are paramount. Therefore:

H_1: Tax Policy positively influences Tax Management effectiveness.

The qualifications, integrity, and service orientation of tax officers significantly influence how taxpayers perceive the tax authority. Fjeldstad and Moore (2009) assert that professional and ethical behavior among tax officials fosters trust, increases voluntary compliance, and reduces enforcement costs. Additionally, well-structured tax departments with clear roles and responsibilities contribute to efficient and responsive service delivery. Thus:

H_2: Tax Officers have a positive effect on Tax Management effectiveness.

Efficient tax administration relies not only on people and policies but also on physical and organizational infrastructure. Alm et al. (2016b) note that sufficient and modern equipment, conducive working environments, and well-coordinated interdepartmental processes are essential to reducing procedural delays and enhancing service quality. This is particularly relevant in Vietnam, where the modernization of tax infrastructure is ongoing. Accordingly:

H_3: Infrastructure for Tax Administration positively affects Tax Management effectiveness.

Enterprise-level awareness of tax obligations, risk of inspection, financial capacity, and digital competencies influence both tax behavior and interaction with the tax system. Ajzen's (1991) TPB supports the notion that perceived behavioral control (e.g., IT literacy, financial capacity) and normative pressures (e.g., fear of audits) enhance tax compliance behavior. Enterprises that proactively manage their compliance are easier to govern and support a more efficient tax system. Therefore:

H_4: Corporate Tax Compliance Awareness positively impacts Tax Management effectiveness.

The adoption of digital platforms in taxation—such as electronic declaration systems, integrated tax data, and online support services—has transformed traditional tax administration. According to the Technology Acceptance Model (Davis, 1989b), user acceptance of digital solutions hinges on perceived usefulness and ease of use. A well-designed e-tax system reduces administrative burden, increases accuracy, and enhances transparency. Thus:

H_5: Digital Technology has a positive influence on Tax Management effectiveness.

Core tax administration functions, including timely communication, appropriate handling of refunds and penalties, and effective grievance redressal, are critical to a well-functioning tax system. It was highlighted that efficient administration not only improves taxpayer experience but also increases government revenue by minimizing tax evasion (Heering et al., 2025). The alignment of these functions with enterprise needs, especially in capital-intensive sectors like construction, enhances effectiveness. Hence:

H_6: Tax Administration Functions positively influence Tax Management effectiveness.

The conceptual model proposed in this study integrates six independent constructs—Tax Policy (TP), Tax Officers (TO), Infrastructure for Tax Administration (ITA), Corporate Tax Compliance Awareness (CTCA), Digital Technology (DT), and Tax Administration Functions (TAF)—that are hypothesized to influence Tax Management effectiveness (TM).

The framework is built upon theoretical lenses from institutional theory, TPB, TAM, and public administration literature, suggesting that both internal capabilities and external support structures collectively shape the quality and outcomes of tax management practices. This model is particularly relevant for transportation construction enterprises, which face complex regulatory, financial, and operational environments.

To validate this framework, the study employs a hybrid methodology that combines Structural Equation Modeling (SEM) and Artificial Neural Networks (ANN). SEM is utilized to test the hypothesized linear relationships and assess model fit, while ANN provides insights into potential non-linear and interaction effects, thereby offering a more nuanced understanding of predictor importance and model robustness.

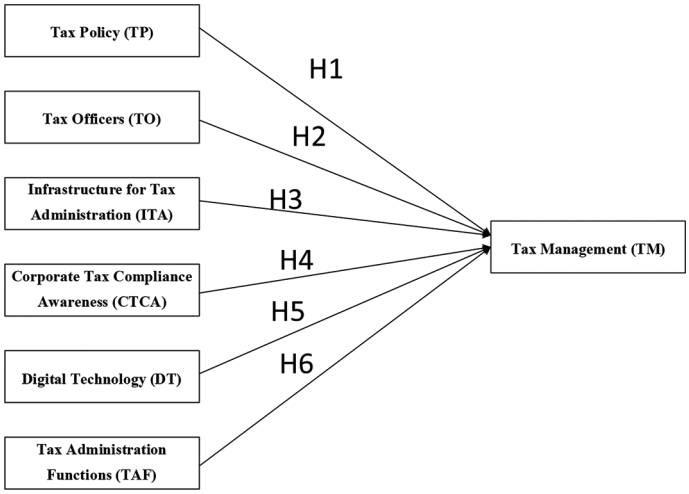
Figure 1 illustrates the conceptual framework, where arrows denote hypothesized causal relationships from the six predictors to the outcome variable, Tax Management effectiveness.

3. RESEARCH METHODOLOGY

3.1. Research Design

This study employed a quantitative, survey-based research design to empirically examine the factors influencing tax management effectiveness among transportation construction enterprises in Hanoi, Vietnam. A structured questionnaire was developed based on validated scales derived from existing literature, encompassing six independent constructs—Tax Policy (TP), Tax Officers (TO), Infrastructure for Tax Administration (ITA), Corporate Tax Compliance Awareness (CTCA), Digital Technology (DT), and Tax Administration Functions (TAF)—and one dependent

Figure 1: Conceptual framework of the study



construct, Tax Management Effectiveness (TM). All items were measured on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

3.2. Sampling and Data Collection

This study employed a structured questionnaire to collect data from construction enterprises engaged in infrastructure projects in Hanoi, Vietnam. The target population comprised businesses operating in the construction sector, specifically those involved in transportation infrastructure development. A combination of purposive and convenience sampling was utilized to ensure that the respondents possessed relevant knowledge regarding tax administration practices within their organizations.

Data were collected between January and April 2025 through two primary channels. First, an online survey was administered via Google Forms, allowing participants to respond at their convenience. Second, face-to-face interviews were conducted to enhance response rates and data reliability, particularly for enterprises less inclined to participate in online surveys. This dual approach helped mitigate non-response bias and ensured broader coverage across different types and sizes of businesses.

In total, 385 valid responses were obtained, which met the minimum sample size requirement based on prior recommendations for structural equation modeling analyses. The sample included a diverse range of respondents in terms of organizational roles, business types, operational histories, company sizes, annual revenues, and prior experiences with tax inspection, as detailed in the Respondent Demographics section.

3.3. Data Analysis Procedure

The data analysis followed a two-stage approach to test both the measurement and structural models. In the first stage, SPSS version 26 was used to perform descriptive statistics, assess data normality, and examine internal consistency through Cronbach's Alpha. Confirmatory Factor Analysis (CFA) and structural model evaluation were then conducted using AMOS version 23, following the guidelines of Hair et al. (2006).

The measurement model was assessed based on factor loadings, composite reliability (CR), average variance extracted (AVE), and discriminant validity using the Fornell–Larcker criterion. Subsequently, the structural model was evaluated through multiple fit indices, including CMIN/DF, RMSEA, GFI, CFI, TLI, SRMR, and PCLOSE. Path coefficients and significance levels were used to test the research hypotheses.

In the second stage, an Artificial Neural Network (ANN) analysis was conducted to complement the SEM findings by uncovering potential nonlinear relationships and assessing the relative importance of predictors. The ANN model, developed using the multilayer perceptron algorithm in SPSS, consisted of one hidden layer and employed a standardized data rescaling method. The dataset was randomly partitioned into training (68.3%) and testing (31.7%) subsets to validate the model's generalizability.

This hybrid SEM–ANN approach allowed for a more comprehensive understanding of both structural dependencies and predictive strengths among variables, thereby enhancing the robustness and explanatory power of the research findings.

4. DATA ANALYSIS AND RESULTS

4.1. Respondent Demographics

The survey comprised responses from 385 participants representing various positions, business types, and operational characteristics within construction enterprises in Hanoi. The distribution of respondents' demographics is summarized in Table 2.

In terms of respondents' positions within their organizations, the largest group consisted of accounting staff (22.08%), followed closely by chief accountants (21.30%) and those in other roles (20.26%). Business owners accounted for 19.22% of the respondents, while chief financial officers (CFOs) made up 17.14%.

Regarding the type of business entity, the sample was relatively balanced across categories. Limited liability companies and businesses classified as "Other" both represented 18.44% of the sample, followed by state-owned enterprises (17.92%), private enterprises (16.62%), foreign direct investment (FDI) enterprises (15.58%), and joint-stock companies (12.99%).

With respect to the operational history, 36.36% of the surveyed businesses had been in operation for over 10 years. Enterprises with less than 5 years of operation constituted 34.29%, while 29.35% had been operating for 5-10 years.

As for company size, measured by the number of employees, 34.55% of firms reported having more than 200 employees, an equal proportion (34.55%) had between 50 and 200 employees, and 30.91% employed fewer than 50 individuals.

In terms of annual revenue, the majority of businesses (67.53%) reported earnings below VND 10 billion. Companies with revenues between VND 10 billion and VND 100 billion accounted for 19.74%, and 11.69% reported revenues exceeding VND 100 billion.

Finally, regarding tax inspection experience, 34.81% of the firms had been inspected once, 33.25% had been inspected multiple times, and 31.95% reported no prior tax inspections.

4.2. Reliability and Validity Analysis

To assess the adequacy of the measurement model, this study conducted a comprehensive evaluation of reliability and validity, including internal consistency, convergent validity, and discriminant validity, as recommended by (Hair et al., 1998; Hair, 2009).

Internal consistency was first examined using Cronbach's Alpha and Composite Reliability (CR). As shown in Table 3, all constructs exhibited Cronbach's Alpha values above the recommended threshold of 0.70 (Hair et al., 2006), ranging from 0.892 (Tax Policy) to 0.952 (Tax Administration Functions), thereby confirming acceptable internal reliability. Similarly, the CR values ranged from 0.933 to 0.960, surpassing the 0.70 benchmark suggested by Hair et al. (2006), further indicating satisfactory construct reliability.

Convergent validity was assessed through the Average Variance Extracted (AVE) and the outer loadings of observed variables. All constructs recorded AVE values above the 0.50 cut-off point (Hair et al., 2014), with scores ranging from 0.776 (Corporate Tax Compliance Awareness) to 0.834 (Infrastructure for Tax Administration), thus confirming adequate convergent validity. Furthermore, factor loadings for all observed indicators exceeded 0.87, with values ranging from 0.871 to 0.929 (Table 4), well above the minimum acceptable threshold of 0.50 (Truong and McColl, 2011). This demonstrates strong associations between indicators and their corresponding latent constructs.

To further assess potential bias arising from common method variance (CMV), the full collinearity assessment approach was adopted following Kock (2015). This method evaluates CMV by examining the inner variance inflation factor (VIF) values for each latent construct in the model. All VIF values were well below the recommended threshold of 3.3, ranging from 1.003 to 1.031, as reported in the output. These results indicate that CMV is unlikely to pose a serious threat to the validity of the findings.

Discriminant validity was examined by analyzing inter-construct correlations. In line with the Fornell-Larcker criterion, the square root of each construct's AVE exceeded its correlations with other constructs, and all inter-construct correlation coefficients were well below the 0.90 threshold (Awang, 2015; Hair et al., 2012). For instance, the highest correlation was between Tax Policy (TP) and Tax Management (TM) at 0.487, suggesting that each construct captured a distinct conceptual domain.

Collectively, the measurement model demonstrated robust psychometric properties, ensuring that the constructs were measured reliably and validly. These results justify proceeding with the structural model to test the hypothesized relationships among latent variables.

4.3. Structural Equation Modelling Analysis

To assess the structural model (Figure 2) and test the proposed hypotheses, a series of model fit indices were examined based on established SEM criteria (Awang, 2015; Hair et al., 2010). These indices help evaluate the extent to which the hypothesized model aligns with the observed data.

The Chi-square to degrees of freedom ratio (CMIN/DF) was 1.124, well below the commonly accepted upper threshold of 3.0, indicating a strong model fit. The Root Mean Square Error of Approximation (RMSEA) was 0.018, with a 90% confidence interval ranging from 0.002 to 0.026, and a PCLOSE value of 1.000. These values suggest an excellent fit between the model and the data, as RMSEA values below 0.06 and PCLOSE above 0.05 are considered desirable (Hu and Bentler, 1999).

Table 2: Summary of respondent demographics (n=385)

Characteristic	Category	Frequency	Percentage
Position	Accounting staff	85	22.08
	Chief accountant	82	21.30
	Other	78	20.26
	Business owner	74	19.22
	CFO	66	17.14
Business type	Limited liability company	71	18.44
	Other	71	18.44
	State-owned enterprise	69	17.92
	Private enterprise	64	16.62
	FDI enterprise	60	15.58
	Joint-stock company	50	12.99
Operational history	Over 10 years	140	36.36
	Under 5 years	132	34.29
	5-10 years	113	29.35
Number of employees	Over 200	133	34.55
	50-200	133	34.55
	Under 50	119	30.91
Annual revenue	Under VND 10 billion	260	67.53
	VND 10-100 billion	76	19.74
	Over VND 100 billion	45	11.69
Tax inspection experience	Once	134	34.81
	Multiple times	128	33.25
	Never	123	31.95

Table 3: Reliability, validity, and correlation results

Construct	Cronbach's alpha	CR	AVE	TP	TO	ITA	CTCA	DT	TAF	TM
TP	0.892	0.939	0.794	1						
TO	0.928	0.946	0.814	0.007	1					
ITA	0.901	0.938	0.834	0.013	0.041	1				
CTCA	0.914	0.960	0.776	0.128	0.069	0.007	1			
DT	0.924	0.950	0.791	0.050	0.088	0.005	0.081	1		
TAF	0.952	0.949	0.822	0.021	0.030	0.024	0.076	0.039	1	
TM	0.934	0.933	0.823	0.487	0.503	0.072	0.266	0.229	0.357	1

Table 4: Outer loadings

Construct	Item	Outer loadings
Tax Policy (TP)	TP1	0.907
	TP2	0.898
	TP3	0.916
Tax Officers (TO)	TO1	0.916
	TO2	0.905
	TO3	0.904
	TO4	0.900
Infrastructure for tax administration (ITA)	ITA1	0.908
	ITA2	0.903
	ITA3	0.929
Corporate Tax Compliance Awareness (CTCA)	CTCA1	0.887
	CTCA2	0.877
	CTCA3	0.897
	CTCA4	0.903
Digital Technology (DT)	DT1	0.915
	DT2	0.901
	DT3	0.900
	DT4	0.893
Tax Administration Functions (TAF)	TAF1	0.871
	TAF2	0.889
	TAF3	0.895
	TAF4	0.871
	TAF5	0.893
	TAF6	0.882
	TAF7	0.864
Tax Management (TM)	TM1	0.885
	TM2	0.889
	TM3	0.878
	TM4	0.897
	TM5	0.897

Other fit indices further supported the model's robustness: the Goodness-of-Fit Index (GFI = 0.931), Adjusted Goodness-of-Fit Index (AGFI = 0.917), and Parsimony Goodness-of-Fit Index (PGFI = 0.769) all exceeded or approached recommended benchmarks. The Standardized Root Mean Square Residual (SRMR) was 0.041, also within the acceptable range of <0.08, confirming the model's adequacy.

Comparative fit indices were equally strong, with the Normed Fit Index (NFI = 0.956), Relative Fit Index (RFI = 0.950), Tucker–Lewis Index (TLI = 0.994), Incremental Fit Index (IFI = 0.995), and Comparative Fit Index (CFI = 0.995) all well above the 0.90 threshold, indicating excellent incremental and comparative fit (Hair et al., 2006).

Parsimony indices, including the Parsimony Normed Fit Index (PNFI = 0.844) and Parsimony Comparative Fit Index (PCFI = 0.878), indicated that the model maintained a strong balance between simplicity and explanatory power. Additionally, the Akaike Information Criterion (AIC = 593.520) and Expected Cross-Validation Index (ECVI = 1.546) were both lower than those of the independence and saturated models, suggesting superior model performance and generalizability.

Finally, the Hoelter's critical N values were 384 at P = 0.05 and 402 at P = 0.01. Given the actual sample size of N = 385, the model meets the required threshold for statistical power at the 0.05 significance level, though it narrowly falls short of the more conservative 0.01 threshold. Nonetheless, this confirms the adequacy of the sample size for achieving model stability and hypothesis testing at conventional confidence levels.

Following confirmation of model fit, path analysis was conducted to test the structural relationships among constructs. As shown in Table 5, all six hypothesized paths were statistically significant ($P < 0.05$), with standardized path coefficients ranging from 0.055 to 0.587. Tax Policy ($\beta = 0.587$; CR = 15.638) and Tax Officers ($\beta = 0.505$; CR = 14.688) had the strongest positive effects on Tax Management effectiveness. Tax Administration Functions also demonstrated a substantial influence ($\beta = 0.384$; CR = 11.731), followed by Corporate Tax Compliance Awareness ($\beta = 0.288$), Digital Technology ($\beta = 0.182$), and Infrastructure for Tax Administration ($\beta = 0.055$), which, though weaker, remained statistically significant ($P = 0.048$).

In sum, the results confirm that all six theoretical constructs meaningfully contribute to explaining variations in tax management effectiveness. The structural model demonstrates a sound empirical foundation for subsequent predictive analysis using Artificial Neural Networks (ANN).

4.4. Artificial Neural Network Analysis

To complement the findings from the Structural Equation Modeling (SEM), an Artificial Neural Network (ANN) analysis was conducted to explore the nonlinear relationships among predictors and to identify their relative importance in influencing tax management effectiveness (TM). The ANN model was developed using a multilayer perceptron (MLP) architecture with a single hidden layer and employed a standard feedforward backpropagation algorithm.

The network structure (Figure 3) included six input neurons corresponding to the significant predictors identified through SEM: Tax Policy (TP), Tax Officers (TO), Infrastructure for Tax Administration (ITA), Corporate Tax Compliance Awareness (CTCA), Digital Technology (DT), and Tax Administration Functions (TAF). All covariates were standardized before training. The hidden layer consisted of six neurons with a hyperbolic tangent activation function, while the output layer, which modeled TM as the dependent variable, used an identity activation function. The error function employed was the sum of squares.

The sample of 385 observations was randomly partitioned into two subsets: 263 cases (68.3%) were allocated to the training sample, while 122 cases (31.7%) were used for testing. The model was trained until the stopping criterion—one consecutive step with no decrease in testing error—was satisfied. The training process was computationally efficient, requiring only 0.07 s.

Model performance was evaluated through the relative error and sum of squares error for both training and testing datasets. The relative error values were 0.257 for the training phase and 0.213 for the testing phase, indicating good predictive accuracy and minimal overfitting. The lower error in the testing set suggests that the model generalizes well to unseen data.

To assess the contribution of each predictor to the outcome, the normalized importance values were calculated. As shown in the

Figure 2: Structural equation modeling framework

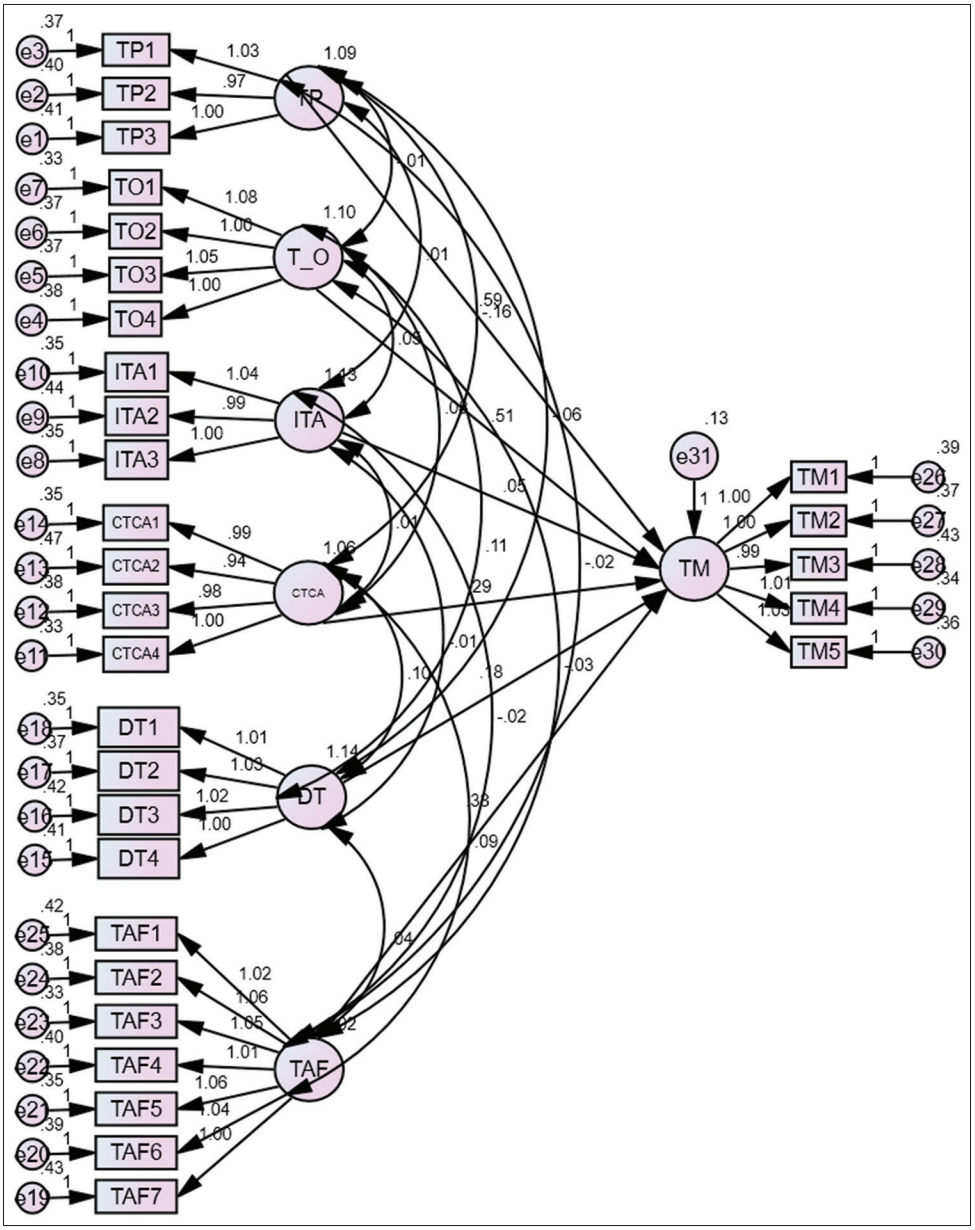


Table 5: Hypothesis testing

Hypothesis	Estimates	S. E	Critical ratio	P-value	Conclusion
H1: TP→TM	0.587	0.038	15.638	***	Supported
H2: TO→TM	0.505	0.034	14.688	***	Supported
H3: ITA→TM	0.055	0.028	1.981	0.048	Supported
H4: CTCA→TM	0.288	0.031	9.290	***	Supported
H5: DT→TM	0.182	0.028	6.426	***	Supported
H6: TAF→TM	0.384	0.033	11.731	***	Supported

***0.000

results (Table 6 and Figure 4), Tax Policy (TP) emerged as the most influential variable with a normalized importance of 100%, followed by Tax Officers (TO) (92.7%), and Tax Administration Functions (TAF) (68.7%). Other predictors such as Corporate Tax Compliance Awareness (CTCA) (54.5%), Digital Technology (DT) (38.1%), and Infrastructure for Tax Administration (ITA) (11.5%) exhibited lower relative importance.

These findings corroborate the SEM results while providing additional insights into the nonlinear effects of the predictors. Notably, while ITA had a statistically significant effect in SEM, its importance in the ANN model was minimal, highlighting the nuanced nature of its influence. Conversely, TP and TO consistently emerged as key drivers of tax management effectiveness, underscoring the centrality of institutional

Table 6: Independent variable importance

Variable	Importance	Normalized importance (%)
TP	0.274	100.0
TO	0.254	92.7
ITA	0.031	11.5
CTCA	0.149	54.5
DT	0.104	38.1
TAF	0.188	68.7

Figure 3: Artificial neural network model

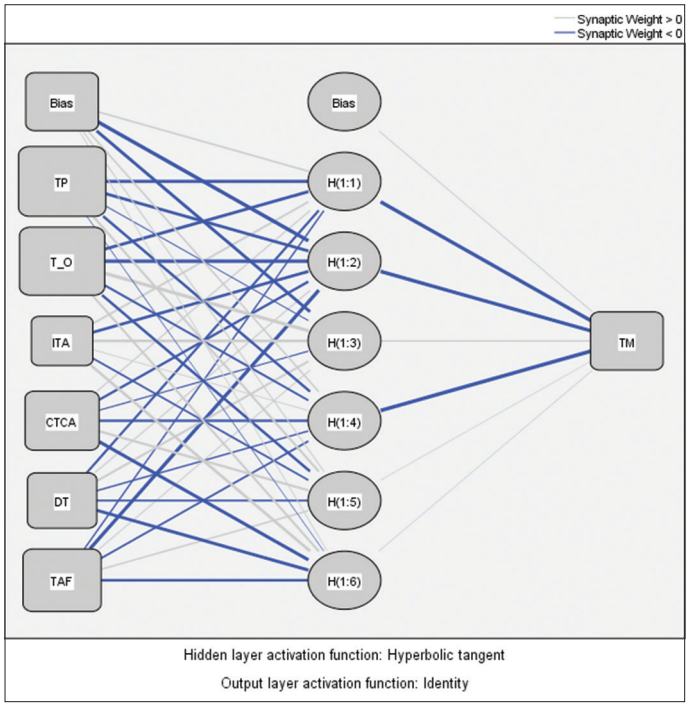
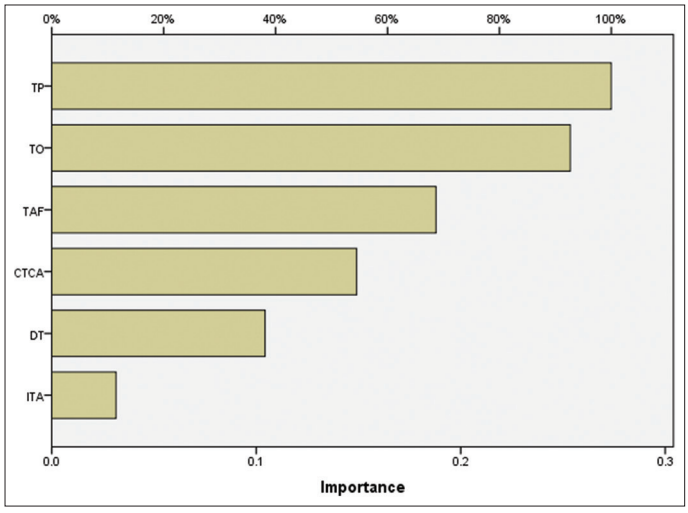


Figure 4: Average normalized importance chart



clarity and personnel quality in shaping administrative performance.

Overall, the hybrid SEM–ANN approach not only confirms the robustness of the linear causal relationships but also offers a richer understanding of variable interactions and relative predictor strength, thereby enhancing the model's explanatory and predictive validity.

5. DISCUSSION

The findings of this study offer important theoretical and practical contributions to the literature on tax management, particularly within the context of infrastructure-oriented enterprises in emerging economies. By employing a hybrid SEM–ANN methodology, the study provides a comprehensive understanding of both the linear causal pathways and nonlinear importance of organizational and technological factors influencing tax management effectiveness.

The SEM results revealed that Tax Policy (TP) and Tax Officers (TO) exert the most substantial effects on the effectiveness of tax management. This underscores the foundational role of a well-structured and industry-specific regulatory framework, as well as the competency, ethics, and service orientation of tax personnel. These findings are consistent with prior studies emphasizing the significance of policy clarity and institutional capacity in enhancing voluntary tax compliance and reducing administrative inefficiencies (Fjeldstad & Moore, 2009).

Tax Administration Functions (TAF) also demonstrated a strong and statistically significant impact, highlighting the operational dimension of tax governance. Efficient processes such as timely communication, audit preparedness, and enforcement mechanisms not only enhance taxpayer experience but also contribute to administrative transparency. This finding reinforces the view that procedural effectiveness is as critical as regulatory soundness in shaping outcomes (OECD, 2019).

Although Corporate Tax Compliance Awareness (CTCA) and Digital Technology (DT) had comparatively moderate standardized coefficients, their significance points to the growing relevance of behavioral and technological readiness among enterprises. Firms with higher levels of compliance awareness, financial capacity, and IT proficiency are more likely to engage constructively with the tax system. This aligns with theoretical expectations drawn from the Theory of Planned Behavior (Ajzen, 1991) and the Technology Acceptance Model (Davis, 1989a,b).

Interestingly, Infrastructure for Tax Administration (ITA), while statistically significant in the SEM analysis, exhibited the lowest normalized importance in the ANN model. This suggests that while internal infrastructure remains relevant, its influence is likely mediated or moderated by other organizational and human resource factors. In practical terms, investing solely in equipment or physical resources may not yield substantial improvements unless accompanied by systemic and behavioral reforms.

The ANN analysis added further depth by ranking the relative importance of predictors in a nonlinear context. It reaffirmed the dominance of Tax Policy and Tax Officers, but also revealed that some variables—despite having statistical significance in SEM—contribute minimally to predictive accuracy. This divergence

between statistical significance and predictive relevance underscores the value of combining SEM with machine learning techniques, particularly in complex administrative environments where linear assumptions may be insufficient.

Collectively, the results affirm that effective tax management is a function of both institutional strength (policy design and enforcement capability) and organizational behavior (awareness, digital readiness, and service delivery). For developing economies undergoing digital transformation, the findings suggest that reforms should balance regulatory innovation with taxpayer support, personnel training, and cross-agency coordination.

6. CONCLUSION AND IMPLICATIONS

This study investigated the determinants of tax management effectiveness in transportation construction enterprises in Hanoi, Vietnam, an industry characterized by high capital intensity, regulatory complexity, and operational fragmentation. By integrating institutional, behavioral, and technological perspectives within a hybrid Structural Equation Modeling–Artificial Neural Network (SEM–ANN) framework, the research provides a comprehensive and nuanced understanding of both linear causal mechanisms and nonlinear predictor importance.

The empirical findings indicate that tax policy clarity, the competence of tax officers, and the quality of tax administration functions are the most influential drivers of effective tax management. These institutional factors not only shape taxpayer behavior but also serve as enablers of compliance and administrative efficiency. Meanwhile, corporate awareness of tax obligations and the adoption of digital technologies play important complementary roles, though their effects are moderated by broader organizational and infrastructural conditions.

The combined use of SEM and ANN has proven valuable in validating theoretical relationships while uncovering hidden patterns that may not be evident through traditional statistical methods alone. The divergence between statistical significance (as shown in SEM) and relative importance (as revealed by ANN) offers practical insights for policy prioritization and resource allocation.

For tax authorities and policymakers, the findings underscore the need to strengthen tax policy design through greater industry alignment and simplification. Capacity-building initiatives targeting tax officers—particularly in professional training, ethics, and digital literacy—are essential to improving service delivery and public trust. Investments in digital platforms should be accompanied by efforts to enhance taxpayer awareness, user support, and IT infrastructure coordination to ensure successful adoption and utilization.

In addition, tax administration reforms should adopt a more holistic approach that combines technological innovation with behavioral and institutional reforms. In the context of project-based enterprises, such as those in the transportation construction sector, flexible regulatory frameworks and proactive communication strategies can significantly improve compliance outcomes.

This study contributes to the growing literature on public finance and tax compliance by demonstrating the value of hybrid methodological approaches in uncovering both structural and emergent relationships. Future research may extend this work by incorporating longitudinal data to capture dynamic behavioral changes over time or by exploring the mediating and moderating roles of institutional trust, perceived fairness, and corruption perception in tax compliance behavior.

This study was limited to construction enterprises in Hanoi, Vietnam, thus its findings may not be generalizable to other regions or industries. Additionally, the cross-sectional nature of the data prevents causal inferences. Future research may benefit from longitudinal data, qualitative case studies, or comparative analysis across industries and regions.

In conclusion, enhancing tax management effectiveness in developing economies requires an integrated strategy that acknowledges the interdependence of policy design, administrative capacity, organizational behavior, and technological adaptation. The insights derived from this study offer a roadmap for both academic inquiry and practical reform.

REFERENCES

Ajzen, I. (1991), The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50(2), 179-211.

Alm, J., Martinez-Vazquez, J., McClellan, C. (2016a), Corruption and firm tax evasion. Journal of Economic Behavior and Organization, 124, 146-163.

Alm, J., Martinez-Vazquez, J., McClellan, C. (2016b), Corruption and firm tax evasion. Journal of Economic Behavior and Organization, 124, 146-163.

Awang, P. (2015), SEM Made Simple: A Gentle Approach to Learning Structural Equation Modeling. Bangi: MPWS Rich Publication.

Bakhshi, S., Zolfaghari, M., Hir, K.A. (2025), Testing the theory of planned tax behavior in predicting the morale and behavior of taxpayers. Audit Knowledge, 25(98), 290-313.

Becker, G.S. (1968), Crime and punishment: An economic approach. Journal of Political Economy, 76(2), 169-217.

Bird, R. (2010), Smart Tax Administration (Economic Premise, No. 36). World Bank. Available from: https://hdl.handle.net/10986/10152

Bird, R.M. (2015), Improving tax administration in developing countries. Journal of Tax Administration, 1(1), 23-45.

Davis, F.D. (1989a), Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 319-340.

Davis, F.D. (1989b), Technology acceptance model: TAM. In: Al-Suqri, M.N., Al-Aufi, A.S., editors. Information Seeking Behavior and Technology Adoption. Pennsylvania, United States: IGI Global. p205-219.

Doan, H.Q., Vu, N.H., Tran-Nam, B., Nguyen, N.A. (2022), Effects of tax administration corruption on innovation inputs and outputs: Evidence from small and medium sized enterprises in Vietnam. Empirical Economics, 62(4), 1773-1800.

Fjeldstad, O.H., Moore, M. (2009), Revenue authorities and public authority in sub-Saharan Africa. The Journal of Modern African Studies, 47(1), 1-18.

General Department of Taxation. (2023), Decision No. 1738/QD-TCT on Establishing the Steering Committee and the Implementation Team for Digital Transformation in the Tax Sector. Vietnam: Government of Vietnam.

Hair, J., Andreson, R., Tatham, R., Black, W. (1998), Multivariate Data Analysis. 5th ed. Unites States of America: Prentice-Hall Inc.

Hair, J.F. (2009), Multivariate Data Analysis. Upper Saddle River: Prentice Hall.

Hair, J.F., Anderson, R.E., Babin, B.J., Black, W.C. (2010), Multivariate Data Analysis: A Global Perspective. Vol. 7. Upper Saddle River, NJ: Pearson.

Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E., Tatham, R.L. (2006), Multivariate Data Analysis. Vol. 6. Upper Saddle River, NJ: Pearson Prentice Hall.

Hayat, N., Salameh, A. A., Mamun, A.A., Helmi Ali, M., Makhbul, Z.K.M. (2022), Tax compliance behavior among Malaysian taxpayers: A dual-stage PLS-SEM and ANN analysis. SAGE Open, 12(3), 21582440221.

Heering, J., Crasnic, L., Newman, A. (2025), When digital taxes come due: National digital taxes and the negotiation of the OECD inclusive framework. New Political Economy, 30(2), 178-193.

Hong, N.T.P. (2022), Factors affecting enforced tax compliance of businesses in Vietnam. WSEAS Transactions on Environment and Development, 18(2), 450-465.

Hu, L., Bentler, P.M. (1999), Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling: A Multidisciplinary Journal, 6(1), 1-55.

Kirchler, E. (2007), The Economic Psychology of Tax Behaviour. Cambridge, United Kingdom: Cambridge University Press.

Kock, N. (2015), Common method bias in PLS-SEM: A full collinearity assessment approach. International Journal of E-Collaboration, 11(4), 1-10.

Kodra, B., Dhamo, S. (2025), Tax Fraud in Financial Statement-Identifying and Measuring Tax Evasion Factors (A Literature and Methodological Review). In: Conference on Organizational Science Development Human Being, Artificial Intelligence and Organization, Conference Proceedings. Univerzitetna Založba Univerze v Mariboru. p437.

Lammers, J.C., Barbour, J.B. (2006), An institutional theory of organizational communication. Communication Theory, 16(3), 356-377.

Ministry of Construction. (2024), Decision 179/QDTTg Approving the Strategy for Development of the Construction Sector through 2030.

Murorunkwere, B.F., Tuyishimire, O., Haughton, D., Nzabanita, J. (2022), Fraud detection using neural networks: A case study of income tax. Future Internet, 14(6), 168.

Nam, N.T. (2025), Determinants of taxpayer satisfaction with e-tax filing services: New evidence from artificial neural networks approach. Journal of Finance-Marketing Research, 3(1), 60-76.

OECD. (2019), Tax Administration 2019: Comparative Information on OECD and other Advanced and Emerging Economies. France: OECD Publishing.

OECD. (2023), Tax Administration 3.0: The Digital Transformation of Tax Compliance. Paris, France: OECD.

Painter, M. (2003), Public administration reform in Vietnam: Problems and prospects. Public Administration and Development, 23(3), 259-271.

Pérez López, C., Delgado Rodríguez, M.J., de Lucas Santos, S. (2019), Tax fraud detection through neural networks: An application using a sample of personal income taxpayers. Future Internet, 11(4), 86.

Pham, T.N. (2020), The role of e-government in fighting against the corruption: A case study of Vietnam. Quantitative Economics and Management Studies, 1(5), 335-345.

Rahman, M.M., Hossain, M.E. (2025), Integrating green tax, green logistics, green climate finance, green technology, and sustainability for a green economy: SEM-ANN approaches. Sustainable Futures, 9, 100795.

Rosid, A. (2022), Predicting Firms' Taxpaying Behaviour Using Artificial Neural Networks: The Case of Indonesia. Available from: https://ssrn.4185966

Scott, W.R. (2005), Institutional theory: Contributing to a theoretical research program. In: Great Minds in Management: The Process of Theory Development. Vol. 37. Oxford, United Kingdom: OUP Oxford. p460-484.

Shi, B., Dong, B., Xu, Y., Wang, J., Wang, Y., Zheng, Q. (2023), An edge feature aware heterogeneous graph neural network model to support tax evasion detection. Expert Systems with Applications, 213, 118903.

Shukla, G.P., Pham, D.M., Engelschalk, M., Le, T.M. (2011a), Tax Reform in Vietnam: Toward a More Efficient and Equitable System. Washington, DC: World Bank.

Shukla, G.P., Pham, D.M., Engelschalk, M., Le, T.M. (2011b), Tax Reform in Vietnam: Toward a More Efficient and Equitable System. Washington, DC: World Bank.

Sun, Y., Rahman, M.M., Xinyan, X., Siddik, A.B., Islam, M.E. (2024), Unlocking environmental, social, and governance (ESG) performance through energy efficiency and green tax: SEM-ANN approach. Energy Strategy Reviews, 53, 101408.

Tina Dacin, M., Goodstein, J., Richard Scott, W. (2002), Institutional theory and institutional change: Introduction to the special research forum. Academy of Management Journal, 45(1), 45-56.

Torgler, B. (2005), Tax morale and direct democracy. European Journal of Political Economy, 21(2), 525-531.

Truong, Y., McColl, R. (2011), Intrinsic motivations, self-esteem, and luxury goods consumption. Journal of Retailing and Consumer Services, 18(6), 555-561.

Vu, T.V., Cao, O.T. (2021), Investigating citizens' concern about corruption and anti-corruption: A case study in Vietnam. Krytyka Prawa. Niezależne Studia Nad Prawem, 13(4), 189-216.