

# Integrating TOE, TAM, and UTAUT to Analyze E-Bidding Effectiveness in Vietnam

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## Abstract

This study develops an integrated conceptual framework to assess the effectiveness of electronic construction tendering (ECT) in Vietnam's public procurement sector. Although ECT is legally mandated, implementation remains uneven, particularly among small and medium-sized enterprises (SMEs). To analyze this complexity, the framework combines three established models - Technology-Organization-Environment (TOE), Technology Acceptance Model (TAM), and Unified Theory of Acceptance and Use of Technology (UTAUT) - capturing key dimensions such as infrastructure readiness, organizational capacity, institutional environment, and user behavior. Notably, the study redefines "attitude toward technology" as an organization's adaptive capacity, rather than individual intention, to reflect Vietnam's semi-coercive digital transition. The proposed model lays the groundwork for empirical testing and offers concrete policy directions, including subsidized training and mobile-based access for rural SMEs, integration incentives for larger firms, and legal reforms to stabilize the regulatory environment. These insights aim to inform more effective and inclusive digital transformation strategies in the construction sector.

## 1. Introduction

In the context of accelerated national digital transformation, the application of information technology in public procurement has been considered a strategic pillar to enhance budget efficiency, promote transparency, and minimize irregularities throughout the bidding process [1]. One of the core tools in this transformation is the Electronic Construction Tendering (ECT) system, which enables all phases of the bidding process to be conducted entirely online, including document submission, evaluation, and award announcement. Vietnam's national e-Government Procurement (e-GP) system, launched in 2009 and made mandatory in 2018 for all state-funded procurement packages, has since become the central infrastructure for public procurement activities [2].

It is also worth noting that in the private sector - where the use of ECT is not yet compulsory - many investors have yet to adopt the system due to concerns over flexibility, procedural constraints, or habitual preference for traditional direct contractor selection methods. Hence, if the research scope is expanded to include decision-makers such as private investors or SMEs that have not yet engaged with ECT, the application of models like TAM, TOE, or UTAUT becomes even more valuable in explaining behavioral patterns and informing policy designs to promote voluntary digital transformation [8].

Building on this foundation, the present study proposes an integrated theoretical framework combining elements from the TOE, TAM, and UTAUT models to examine factors influencing the effectiveness of ECT implementation in Vietnam's construction sector, with a particular focus on small and medium-sized enterprises. Rather than seeking to explain the binary decision of "whether to use," the study aims to identify how organizational, technological, environmental, and individual behavioral factors affect operational efficiency in a digitally mandated procurement environment. The ultimate goal is to provide robust scientific evidence to support the development of responsive and effective policy interventions.

Despite the existence of multiple models for analyzing technology adoption, few studies have proposed an integrated conceptual model that accounts for both the mandatory nature of public procurement and the diverse capacity of stakeholders such as SMEs. This study addresses that gap by developing a TOE-TAM-UTAUT framework tailored for Vietnam's construction sector. The objective is to understand not just the decision to adopt, but the underlying organizational, technological, and institutional factors shaping ECT implementation effectiveness.

## 2. The Current State of E-Bidding in Vietnam

Vietnam's electronic bidding system - officially known as the National E-Government Procurement System (e-GP System) - is developed and managed by the Public Procurement Agency under the Ministry of Planning and Investment. Initially launched as a pilot in 2009, the system became mandatory in 2018 for all procurement packages funded by the state. As stipulated by the Law on Procurement No. 22/2023/QH15, starting from January 1, 2025, the application of electronic bidding will be compulsory for all public sector procurement packages [4]. The e-GP system consolidates the entire bidding process - including bid invitation posting, bid submission, evaluation, and result announcement - into a unified digital platform, supported by digital signatures and centralized data storage for traceability. By 2024, over 160,900 procurement packages had been processed online, representing 99.97% of eligible packages, with a total transaction value reaching VND 866.464 trillion [3].

On the other hand, private investors - who are not legally mandated to use the e-GP system - tend to prefer traditional contractor selection methods, such as paper-based bidding or informal approaches through social networks and independent platforms. This reluctance is largely attributed to concerns over the rigid structure of the e-procurement process, reduced flexibility in selecting familiar contractors, and the difficulty of integrating internal systems with the national e-GP platform [8]. This indicated the theoretical and practical relevance of analyzing ECT acceptance behavior among stakeholder groups that still retain the discretion to opt in - such as SMEs that have not yet participated or private sector investors.

Additionally, the characteristics of Vietnam's construction industry pose further complications for digital procurement adoption. The sector is highly fragmented, heavily reliant on subcontractors, typified by small-scale packages, and burdened with complex administrative procedures. Affendy et al. (2022) emphasize that in technologically intensive industries like construction, the main barrier for SMEs is not the upfront cost of technology adoption, but rather the presence of conservative organizational cultures and a lack of ongoing training policies [9]. Consequently, even when legally compelled, many firms only engage in a token manner or eventually withdraw from public procurement altogether.

Therefore, studying ECT acceptance behavior and implementation effectiveness should focus on two key target groups: (i) SMEs - who are legally bound to participate but are practically excluded due to internal barriers; and (ii) private investors - who have complete discretion but have yet to choose ECT as a contractor selection tool. Investigating and analyzing the behavior of these two groups will help identify the technological, organizational, behavioral, and environmental factors influencing their decision-making and operational effectiveness. This, in turn, will form a scientific foundation for developing more tailored and effective policy recommendations.

## 3. Literature Review

In the context of digitalizing public procurement, many countries have conducted in-depth studies to evaluate the effectiveness and influencing factors associated with the adoption of electronic procurement systems (e-Procurement, e-Bidding). International research has shown that the success of such systems does not rely solely on technical infrastructure but is also closely tied to user acceptance behavior, organizational capabilities, regulatory frameworks, and enabling environmental conditions [1, 10].

Several studies have proposed combining theoretical models to address the complexity of analyzing technology acceptance behavior in mandatory contexts. Oliveira and Martins (2011) and Ifinedo (2011) recommended integrating the Technology-Organization-Environment (TOE) framework with TAM or UTAUT to expand the scope of analysis from the individual level to include organizational and regulatory environments - an approach particularly effective for studies involving e-Government or public procurement systems [7, 13]. This integration helps overcome the limitations of standalone models, such as TAM's lack of consideration for organizational dynamics or UTAUT's limited attention to sector-specific characteristics. More recently, Williams

et al. (2015) confirmed that combining UTAUT with TOE enhances explanatory power for user behavior in mandatory government systems, such as ECT in developing countries [14].

In the Vietnamese context, research on electronic bidding remains fragmented. The study by Van Tam et al. (2025) employed an empirical approach to identify technical and behavioral barriers to ECT adoption, but it did not develop an integrated theoretical framework [6]. Other studies have focused on institutional analysis or qualitative assessments of user satisfaction, lacking a robust conceptual foundation to test relationships between technological, organizational, and behavioral factors. To date, no study in Vietnam has constructed a comprehensive theoretical model that both reflects the mandatory nature of the system and explains the determinants of implementation effectiveness within the specific context of the construction sector and SMEs.

Drawing from international literature and identifying gaps in the domestic research landscape, it becomes clear that: (i) applying models such as TOE, TAM, and UTAUT is appropriate for addressing the research problem of ECT implementation effectiveness in a mandatory administrative environment, and (ii) integrating these models enables a holistic examination of technological, organizational, institutional, and user behavioral factors. This forms the foundation for the present study to develop an integrated TOE - TAM - UTAUT framework aimed at analyzing key drivers of effective ECT implementation in Vietnam's construction sector.

## 4. Theoretical Foundations

This section also serves as the research methodology in this conceptual study, outlining the theoretical basis and process of model integration

### 4.1. Technology-Organization-Environment (TOE) Framework

The TOE framework, developed by Tornatzky and Fleischer (1990), provides a comprehensive theoretical lens to analyze technology adoption and implementation within organizations through three primary dimensions: Technology, Organization, and Environment [15]. Widely applied in studies on technological innovation at the organizational level, TOE is particularly relevant in public sector contexts and technically complex industries such as construction. Within the scope of electronic construction tendering (ECT) in Vietnam, each TOE dimension can be specified as follows.

The technology dimension refers to the technical attributes and the system's compatibility with the organization's current capabilities. For construction enterprises, the ECT system must ensure compatibility with internal management software, user-friendliness, and high security to safeguard sensitive technical and financial bid documents. Incompatibility or high IT skill requirements exceeding user capabilities reduce acceptance and practical adoption. In practice, many SMEs lack the technological infrastructure or software upgrade capabilities necessary for effective participation in digital procurement [3].

The organizational dimension includes internal factors such as workforce capability, management procedures, and top management support. In construction firms, bidding staff are often multitasking across roles, which limits their ability to master new systems. Executive support plays a critical role, as it pertains to financial commitment, personnel training decisions, and restructuring processes to accommodate e-bidding formats. According to Zhu et al. (2006), organizations with an innovation-driven culture and flexible management systems are more likely to successfully adopt new technologies [16].

The environmental dimension refers to external factors such as legal frameworks, competitive pressure, and governmental support. Vietnam's e-procurement legal framework is undergoing rapid updates, with numerous circulars and decrees amended within short timeframes. This creates compliance challenges, especially at the local level. In addition, requirements by international donors to apply e-bidding in ODA projects and market competition also pressure firms to adapt quickly to digital systems [1].

Hence, the TOE framework not only helps categorize influential factors affecting ECT adoption but also enables the development of observable variables aligned with the specific conditions of Vietnam's construction sector. Embedding this framework in the theoretical analysis provides a structured foundation to understand both barriers and enablers for effective and sustainable ECT implementation.

### 4.2. Technology Acceptance Model (TAM)

In the context of electronic construction tendering in Vietnam, TAM offers a valuable theoretical lens for analyzing user behavior among procurement officers, contractors, and other stakeholders. Numerous studies have shown that users are more likely to adopt new technologies when they perceive tangible benefits - such as reduced processing time, minimized errors, and enhanced transparency [18].

Perceived Usefulness in the ECT system may include easier access to bid invitations, streamlined submission processes, and improved competitiveness. Additionally, PU manifests in cost reductions related to printing, travel, and staffing through the digitalization of the entire bidding process. According to surveys conducted by the

Ministry of Planning and Investment, enterprises using ECT save on average 10 - 15% in bidding costs compared to traditional methods [3].

PEOU reflects the intuitiveness of the user interface, technical complexity, and required IT skills. For many small contractors or local government staff, challenges such as digital signatures, file uploads, or error handling can become major deterrents. Improving user interfaces, offering support tools, and organizing regular training programs can significantly enhance PEOU and, indirectly, PU.

Although TAM is structurally simple, it offers effective explanatory power, especially in public sector environments with administrative complexity. However, its limitations lie in its neglect of environmental and organizational variables. Thus, combining TAM with models like TOE and UTAUT allows for a more holistic understanding of user behavior in ECT systems.

### 4.3. Unified Theory of Acceptance and Use of Technology (UTAUT)

Referring to Table 1, In the context of ECT implementation in Vietnam’s construction sector, UTAUT provides a detailed framework to explain user acceptance behavior among contractors, procurement officers, and technical staff.

Performance Expectancy (PE) reflects users’ belief that the system will enhance productivity and efficiency. In construction procurement, this includes reduced processing time, lower transaction costs, and improved transparency in bidder evaluation. The entire process - from preparing and appraising bid documents to approval and result disclosure - is fully digitized. As a result, processing time is significantly reduced compared to traditional methods, while procedural accuracy and transparency are maintained. Stakeholders can perform digital operations and electronic signatures directly on the e-GP platform [3].

Effort Expectancy (EE) refers to users’ perceived ease of use. For small construction firms or non-technical personnel, tasks such as digital signing, uploading documents, or troubleshooting system errors can be major obstacles. EE is therefore a decisive factor in whether users continue using the system after their first experience [18].

Social Influence (SI) captures the impact of important referents - such as supervisors, colleagues, or industry peers - on an individual's decision to adopt technology. This factor is especially prominent in state agencies or state-owned enterprises, where adoption decisions are often influenced by directives from higher authorities or industry norms. Successful adoption by major contractors can exert competitive pressure and motivate smaller firms to follow suit.

Facilitating Conditions (FC) denote the extent to which an organization provides the necessary support for users through technical infrastructure, guidance materials, IT support, and training programs. According to Huynh Quoc Dinh (2022), training for procurement staff has not been uniformly implemented across Vietnam. Only a limited number of training sessions have been held in major cities, resulting in inconsistent capacity among local-level personnel. This disparity negatively affects the effectiveness of ECT implementation at the grassroots level.

**Table 1** Comparison between TAM and UTAUT

Factor	TAM	UTAUT	Common Variable
Performance Expectancy	Perceived Usefulness (PU)	Performance Expectancy (PE)	Productivity, value perception
Effort Expectancy	Perceived Ease of Use (PEOU)	Effort Expectancy (EE)	Usability, system simplicity
Social Influence	(Not directly modeled)	Social Influence (SI)	Peer pressure, institutional norms
Facilitating Conditions	(Not included)	Facilitating Conditions (FC)	Infrastructure, technical support

(Source: Author’s compilation)

Overall, UTAUT is a well-suited model for analyzing user behavior in the field of electronic construction tendering, particularly when combined with frameworks such as TOE and TAM. This integration allows the research to move beyond individual perceptions to encompass organizational and environmental influences, thereby establishing a robust theoretical foundation for subsequent quantitative and qualitative analyses.

## 5. Proposed Integrated TOE + TAM + UTAUT Model

### 5.1. Theoretical Basis of the Integrated Model

Although UTAUT incorporates key elements of TAM - specifically, performance expectancy and effort expectancy, which correspond to perceived usefulness (PU) and perceived ease of use (PEOU), respectively - the direct inclusion of TAM constructs remains fully justified for several reasons.

First, PU and PEOU have been more widely applied and validated in public sector and semi-coercive contexts [1]. This offers significant practical advantages for empirical measurement and survey design, particularly in specific contexts such as e-bidding in Vietnam, where technology adoption can be influenced by institutional regulations and organizational requirements. These variables provide both operational simplicity and measurement robustness [30].

Second, maintaining TAM constructs allows the model to retain sensitivity to nuanced user perceptions, especially among users with varying levels of digital literacy, which is often observed within Vietnamese small and medium-sized enterprises (SMEs) [31].

Third, empirical studies have consistently shown that combining TAM and UTAUT can improve predictive power [32 - 35]. This integration enables cross-validation of overlapping constructs while preserving their distinct operational interpretations. Consequently, the integrated model offers a more robust explanation of technology acceptance, enhancing its explanatory power compared to using either model in isolation [33].

Therefore, this integration is not redundant; rather, it enhances the model's robustness and adaptability in contexts where user perception varies significantly due to both institutional mandates and organizational readiness.

The integration of the TOE, TAM, and UTAUT models stems from the need to comprehensively investigate factors influencing the acceptance and implementation of technology in organizations. Each model possesses distinct strengths while also exhibiting certain limitations. When combined, these models complement each other to form a more robust theoretical framework - well-suited to the specific context of electronic construction tendering (ECT), which involves diverse stakeholders with varying capacities, expectations, and legal obligations.

The selection of TOE, TAM, and UTAUT for this integrated framework is based on extensive literature synthesis and empirical relevance to e-procurement contexts. TOE addresses organizational and external uncertainties; TAM captures individual-level perceptions; and UTAUT incorporates social influences and infrastructure conditions. These models are not only theoretically sound but also empirically validated in public sector technology applications, making them particularly appropriate for analyzing ECT in developing contexts such as Vietnam [7, 14].

The TOE model emphasizes the organizational and environmental context, which greatly affects technology acceptance at a macro level [15]. However, it lacks focus on the psychological and behavioral dimensions of end-users who directly interact with ECT systems. Conversely, TAM excels at analyzing individual perceptions - particularly perceived usefulness (PU) and perceived ease of use (PEOU) - but lacks a broader view of organizational and environmental influences [17, 20].

UTAUT, developed by Venkatesh et al. (2003), marks a significant advancement by integrating social influence, facilitating conditions, and increasing predictive power for user behavior [18]. Nonetheless, UTAUT still does not fully reflect organizational barriers, especially in public sector settings where legal, institutional, and cultural factors play a significant role [14].

Therefore, the integration of TOE - TAM - UTAUT is both a necessary and appropriate approach to:

1. Combine structural analysis of organizations and environments (TOE) with individual-level perception and behavior (TAM, UTAUT);
2. Clarify the interaction mechanisms across levels of analysis - from individual users to organizational and institutional actors;
3. Lay the foundation for developing empirical testing models with high predictive accuracy and applicability.

Oliveira & Martins (2011) demonstrated that combining TOE with TAM effectively explains technology adoption in organizational e-commerce contexts [21]. Subsequent studies [13, 22] also affirmed that integrated models yield more reliable results when evaluating technology acceptance in complex industries such as construction, logistics, or public healthcare.

In the context of Vietnam's push toward digital transformation in public procurement, the TOE - TAM - UTAUT model serves as a powerful analytical tool that fully reflects technological, organizational, social, and behavioral dimensions. It offers a solid theoretical basis for both quantitative and qualitative research, as well as policy recommendations.

## 5.2. Proposed Factor Groups and Variables

In the proposed model, the three input constructs - TECH, ORG, and ENV - are defined based on both theoretical foundations and empirical realities in Vietnam's construction sector:

- TECH (Technological Readiness) refers to an enterprise's technological infrastructure and system integration capacity, including internet access, data security protocols, compatibility with ERP software, and ease of use. It also includes the level of automation, software reliability, and availability of IT support.
- ORG (Organizational Capability) encompasses internal factors such as leadership commitment, employee IT competence, process standardization, and organizational culture. It reflects how well an enterprise is structured to adapt and sustain ECT, including through change management practices and staff training policies.
- ENV (Environmental Context) captures external influences such as the legal and institutional framework, market competition, and support from governmental or international agencies. Rapid policy changes, donor requirements, and disparities in local enforcement mechanisms are all part of this dimension.

The dependent variable, E-Bidding Effectiveness, is conceptualized as the degree to which firms achieve successful outcomes when using the ECT system. These outcomes include error-free bid submissions, compliance with deadlines, cost savings, bid success rates, and perceived transparency improvements. This effectiveness is influenced by how well firms convert input factors into operational readiness and outcomes.

At the organizational level (ORG), the IT competence of personnel responsible for preparing bid documents is crucial to ensuring the accuracy and timeliness of bidding activities. Many SMEs lack knowledge of file formatting or digital signatures, resulting in a high rate of bid disqualification due to technical errors. The need for training and professional development remains a significant gap in the construction sector [24, 25]. Moreover, top management support plays a decisive role in technology investment and digital transformation initiatives. When leadership lacks vision or commitment, organizations tend to resist change. Organizational culture - including openness to change, innovation readiness, and internal communication - emerges as a critical variable. Public-sector entities often operate in risk-averse environments, with resistance to change and rigid hierarchies that hinder proactive digital adoption [26]. A culture that fosters innovation, inter-departmental collaboration, and technology experimentation is essential for successful ECT adoption.

From the environmental perspective (ENV), the legal and policy framework is a key determinant of e-procurement success. Although Vietnam has made progress, frequent policy changes - such as Circular 11/2019/TT-BKHD [2], Circulars 08/2022 and 10/2022 [27, 28], and the 2023 Procurement Law mandating nationwide e-bidding by 2025 [4] - create compliance challenges, especially for SMEs. In addition, industry competition acts as a catalyst for digital transformation, compelling firms to adopt e-bidding to maintain competitiveness in large-scale tenders [29]. However, government support remains limited. Many provincial Departments of Planning and Investment have yet to organize comprehensive training, and mandatory donor requirements (e.g., from ADB or WB) often lack accompanying technical or financial support.

In traditional models such as TAM and UTAUT, the variable "ATT" (Attitude/Acceptance) is typically defined as an individual's behavioral intention to accept and use technology, influenced by PU and PEOU [17, 18]. However, in Vietnam's context - where ECT use is mandatory for public-funded projects - this definition is no longer adequate. Decision-making lies with organizational leadership, not individual users, and many organizations outsource ECT-related tasks instead of building internal capacity [6].

Therefore, this study proposes redefining ATT from an individual-level cognitive variable to an organizational-level construct, reflecting the extent to which an enterprise has institutionalized and operationalized ECT as a routine business activity. Specifically, ATT is defined as an organization's adaptive capacity in effectively implementing ECT, regardless of whether it relies on internal or outsourced resources. This variable measures the extent to which an organization:

- Proactively develops tailored e-bidding processes;
- Coordinates effectively among legal, technical, and procurement departments;
- Ensures quality control of bidding documents and minimizes technical errors;
- Maintains a long-term strategy for sustaining or enhancing ECT capabilities.

This reconceptualization aligns with Vietnam's realities, where the e-bidding service market is growing, but execution outcomes vary widely depending on internal technological capabilities, organizational processes, and administrative coordination. As such, ATT no longer represents a binary decision of "use or not use," but rather reflects the operational effectiveness of ECT implementation within organizations.

This revised definition of ATT is also consistent with recent research in e-government and mandatory administrative technologies, where scholars emphasize that "technology acceptance in coercive environments should be understood as an organizational adaptation capability, rather than a matter of individual behavioral choice" [7, 14].

To operationalize the proposed constructs, a structured survey instrument has been developed and piloted among experts in construction and procurement. The instrument includes 5-point Likert-scale items corresponding to each construct: Technological, Organizationally, Environmental/Regulatory Conditions, Operational Capacity (ATT-Mediating Variable). A detailed list of items is available in the appendix or upon request. This alignment ensures that the conceptual model is empirically testable and suitable for SEM analysis in the Vietnamese construction context. Table 2 summarizes the observed variables developed for each construct in the proposed model. The items were designed for a 5-point Likert scale and reflect core dimensions derived from the TOE - TAM - UTAUT framework.

**Table 2** Measurement items for constructs in the integrated TOE - TAM - UTAUT model

Code	Construct / Dimension	Item Description (5-point Likert Scale)
<b>Technological Factors (TECH)</b>		
TECH1	Technological Stability	Stability of the ECT platform
TECH2	Information Security	Level of data and information security
TECH3	Infrastructure Quality	Quality of IT infrastructure at the enterprise
TECH4	User Interface Design	User-friendliness of the ECT interface
TECH5	System Integration Capability	Compatibility with internal enterprise software
TECH6	Technical Support Services	Quality of technical support services
TECH7	Operational Costs	Cost of running and maintaining the ECT system
TECH8	System Upgrades and Updates	Frequency of ECT system updates and improvements
<b>Organizational Factors (ORG)</b>		
ORG1	IT Competency	ICT competency of organizational staff
ORG2	Leadership Commitment	Leadership commitment to ECT implementation
ORG3	Training Quality	Quality of internal training programs on ECT
ORG4	Digital Adaptation Culture	Organizational culture supporting digital transformation
<b>Environmental Factors (ENV)</b>		
ENV1	Legal Stability	Stability and consistency of legal regulations
ENV2	Guideline Clarity	Clarity of implementation guidelines
ENV3	Monitoring Mechanisms	Effectiveness of compliance monitoring systems
ENV4	Local Support Policies	Existence of local support policies for implementation
ENV5	Regulatory Pressure	Pressure to comply from regulatory authorities
ENV6	Client Enforcement	Mandatory requirements imposed by project owners
ENV7	Competitive Pressure	Pressure from competitors
<b>Operational Capacity (ATT - Mediating Variable)</b>		
ATT1	Process Optimization	Proactiveness in process optimization
ATT2	Interdepartmental Coordination	Effectiveness of cross-department coordination
ATT3	Documentation Quality Control	Quality control in bid documentation
ATT4	Strategic Orientation	Long-term strategic planning for ECT
ATT5	Outsourcing Oversight	Oversight of outsourced ECT services

### 5.3. Proposed Theoretical Model

Traditional technology adoption studies have demonstrated the effectiveness of the TAM, TOE, and UTAUT models in analyzing user behavior, particularly in voluntary contexts [7, 17, 18]. However, in the case of Vietnam's Electronic Construction Tendering (ECT) system - where usage has become mandatory under Law No. 22/2023/QH15 [4] - "technology acceptance" is no longer an individual choice but a legal obligation for organizations. This necessitates a conceptual shift from behavioral intention to organizational capability and implementation effectiveness.

E-Bidding Effectiveness, the core dependent variable of this study, is defined as the cumulative outcome of a firm's ability to operate, comply with, and derive value from the ECT system in practice. However, this

effectiveness is not uniform and varies across stakeholders: for contractors, it concerns effective access and bid success; for project owners, reduced processing time and increased transparency; and for regulators, improved disbursement efficiency and risk control [1].

To explain this performance variation - especially among SMEs - this study proposes an integrated theoretical model combining the three foundational frameworks: TOE, TAM, and UTAUT. Each model contributes to a multidimensional analytical structure:

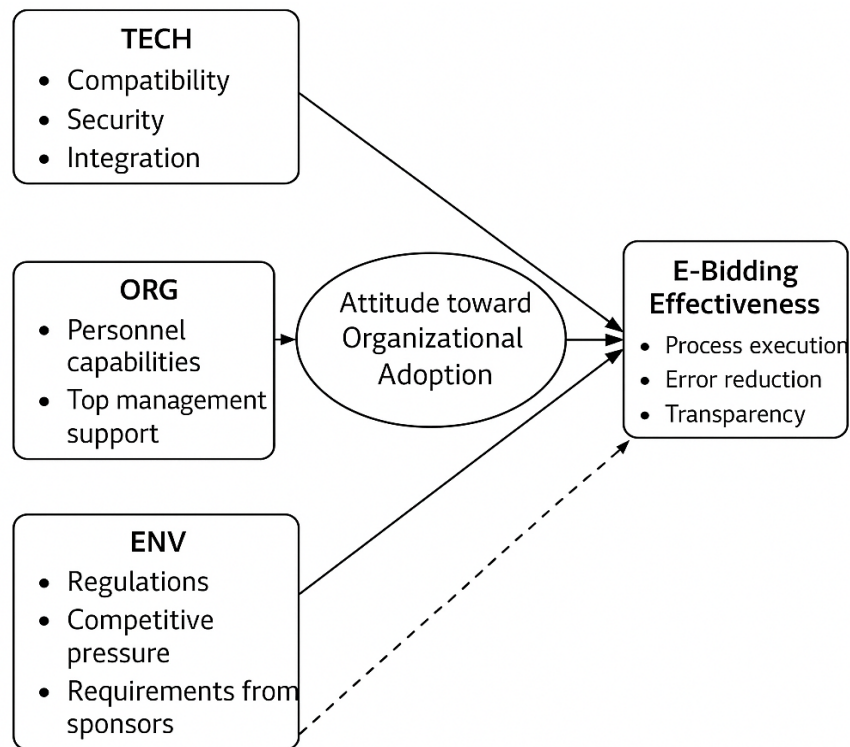
- TOE provides an organizational-level lens to assess technological readiness (TECH), internal capacity (ORG), and regulatory-policy environment (ENV) [7];
- TAM adds perceived usefulness and ease of use, useful for evaluating operational capability [17];
- UTAUT contributes performance expectancy, social influence, and facilitating conditions, capturing the compulsory and cross-functional dynamics in Vietnamese construction firms [18].

The integrated TOE - TAM - UTAUT framework is particularly well-suited to the Vietnamese e-bidding context due to its ability to capture the multi-level and semi-coercive nature of digital transformation in the construction sector. First, the TOE framework accounts for structural challenges prevalent among Vietnamese SMEs, such as inadequate IT infrastructure, fragmented organizational processes, and evolving regulatory environments - factors that directly affect participation in the mandatory e-bidding system. Second, although legal mandates compel usage, TAM constructs such as perceived usefulness (PU) and perceived ease of use (PEOU) remain highly relevant in shaping how procurement staff and organizations engage with the system on a daily basis, especially when technical complexity, limited training, and low digital literacy persist. Third, UTAUT dimensions - including social influence and facilitating conditions - are crucial in a top-down administrative setting like Vietnam, where compliance behavior is often shaped by hierarchical directives, peer benchmarking, and the availability of external technical support. Importantly, the model's reconceptualization of "attitude toward technology" (ATT) as an organizational adaptation capacity, rather than an individual behavioral intention, reflects the operational realities of firms that outsource digital bidding tasks or lack internal competencies. By combining these theoretical lenses, the proposed model offers a context-sensitive, empirically grounded approach for analyzing implementation effectiveness, particularly among resource-constrained SMEs navigating a legally enforced but unevenly supported digital transition.

A distinctive feature of this integrated model is the redefinition of the mediating variable "ATT" - from individual intention in traditional studies to organizational operational capacity in this context. Specifically, ATT represents how far an enterprise has: (i) developed internal processes tailored to ECT; (ii) proactively trained or outsourced key personnel; (iii) minimized technical errors and delays; (iv) formulated long-term strategies to sustain effective system usage.

This approach aligns with Vietnam's reality, where the e-bidding service market is mature, but execution effectiveness remains uneven among firms. As Van Tam et al. (2025) observed, SMEs often struggle with process coordination - even when outsourcing - due to weak internal standards and poor quality control [6]. This underscores that performance hinges not on the method of delivery (in-house vs. outsourced) but on how well ECT is embedded into operational routines.

In summary, the proposed TOE - TAM - UTAUT integrated model explains three levels of influence on ECT effectiveness: input conditions (TECH, ORG, ENV), intermediate operational capacity (ATT), and final outcomes (E-Bidding Effectiveness). This model forms the empirical testing basis through factor analysis and structural equation modeling (SEM), enabling assessment of each factor group's impact and informing policy recommendations tailored to enterprise type and locality.



**Fig. 1** Proposed integrated TOE - TAM - UTAUT theoretical model

The integrated TOE - TAM - UTAUT theoretical model illustrated in Figure 1 reflects the multidimensional structure of factors influencing the effectiveness of Electronic Construction Tendering (ECT) implementation in the context of Vietnam. The model comprises three main input dimensions:

- Technology (TECH), representing the system's compatibility, security, and integration capabilities;
- Organization (ORG), indicating personnel competencies, leadership support, and organizational culture;
- Environment (ENV), encompassing legal regulations, competitive pressure, and donor requirements.

These input factors exert both direct and indirect effects on the mediating variable ATT - Attitude Toward Organizational Adoption, which is redefined as the degree to which a firm has proactively adapted to the ECT system, whether through internal resources or external services. This organizational readiness translates into sustained and effective implementation capacity.

ATT plays a pivotal role in connecting the input conditions with the outcome variable, E-Bidding Effectiveness, which is measured by the enterprise's ability to execute digital bidding processes efficiently, reduce technical errors, shorten processing time, and improve transparency.

To operationalize this conceptual framework, the authors plan a pilot empirical study that targets a stratified sample of 30 - 50 construction firms across diverse regions and organizational scales in Vietnam. Each construct - TECH, ORG, ENV, ATT, and E-Bidding Effectiveness - will be measured using observable indicators adapted from validated literature[16, 17, 18].

The survey will utilize a 5-point Likert scale to capture perceptions, readiness, and performance metrics. Data will be analyzed using Exploratory Factor Analysis (EFA) for construct validity, followed by Partial Least Squares Structural Equation Modeling (PLS-SEM) to test the hypothesized relationships. This empirical phase will help refine the model, validate the proposed paths, and quantify the strength of direct versus mediated effects.

Additionally, the model assumes that TECH, ORG, and ENV may have direct influences on E-Bidding Effectiveness, independent of ATT, as indicated by the dashed arrows. This acknowledges that some firms can achieve high effectiveness due to strong infrastructure or legal advantages, even with low internal adaptation. However, empirical testing will determine whether these effects are partial or fully mediated by ATT.

This theoretical framework also serves as a foundation for designing the survey instrument using validated Likert-scale constructs. The model will be empirically tested using Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM) in subsequent quantitative studies. It will also incorporate stratified variables such as enterprise **size** and **geographic location** (e.g., urban vs. remote areas). This stratification is essential given the significant variation in resource availability, digital literacy, and institutional support between SMEs in remote provinces and large firms in urban centers like Hanoi or Ho Chi Minh City. Tailoring policy interventions based on stratified insights can significantly enhance their effectiveness.

## 6. Discussion

The integrated TOE - TAM - UTAUT model proposed in this study offers two core contributions: (i) it expands the analytical scope from individual user behavior to organizational capabilities in a mandatory technological environment; and (ii) it links technological, organizational, and environmental factors with actual operational outcomes, rather than stopping at theoretical acceptance behavior. However, to fully realize the model's practical value, a deeper discussion is needed on how it can be applied to solve specific real-world problems.

The central question is: How can construction enterprises - especially SMEs - improve the effectiveness of ECT implementation under mandatory conditions despite limited operational capacity? To systematically address this question, the study proposes a four-step application framework based on the integrated TOE - TAM - UTAUT model:

### **Step 1 - Assess the current state using the model:**

Enterprises conduct internal assessments based on the model's key dimensions: TECH (IT infrastructure and cybersecurity), ORG (human resource capacity and internal processes), ENV (institutional context and external pressure), ATT (organizational capability to operate ECT), and output indicators (number of valid bids, processing time, bid success rate).

### **Step 2 - Analyze data and identify bottlenecks:**

Survey data is processed using Structural Equation Modeling (SEM) to identify which group of factors has the most significant impact on effectiveness. For instance, if ATT is the primary bottleneck, it indicates the organization lacks coordination mechanisms or fails to manage outsourced services effectively.

### **Step 3 - Design targeted interventions:**

Based on the identified bottlenecks, the organization selects appropriate strategies: invest in technology if TECH is weak; implement training or process redesign if ORG is underperforming; or engage in policy negotiation if ENV poses regulatory barriers. If ATT is the key mediating factor, organizations should focus on internal quality control systems and strengthen oversight of outsourced services.

### **Step 4 - Monitor and refine:**

Post-intervention, the organization should reassess ECT outcomes on a cyclical basis (every 3 - 6 months) while monitoring changes in the model's core factor groups to adapt implementation strategies accordingly.

This application framework has value not only for individual enterprises but also for broader use in developing an ECT readiness index at the sectoral or regional level. Such an index can support targeted policy interventions by region or firm size. In this way, the TOE - TAM - UTAUT model extends beyond academic analysis to become a tool for evaluating and improving ECT implementation on a national scale.

Moreover, the model addresses common gaps in prior Vietnamese studies, which often focused on describing technological or legal barriers without constructing a measurable, testable effectiveness framework. By redefining ATT from a personal behavioral intention to an organizational operational capability, the model for the first time enables a structured link between input conditions, intermediate organizational capacities, and execution outcomes. This reflects the true nature of Vietnam's coercive administrative environment and the growing role of external service providers.

While UTAUT incorporates core elements of TAM - specifically, performance expectancy and effort expectancy, corresponding to perceived usefulness (PU) and perceived ease of use (PEOU) - the direct inclusion of TAM constructs remains fully justified for several reasons. First, PU and PEOU have been more widely applied and validated in public sector and semi-coercive contexts, offering significant practical advantages for empirical measurement and survey design, particularly in specific settings like e-bidding in Vietnam. These variables provide both operational simplicity and measurement robustness [30]. Second, maintaining TAM constructs allows the model to retain sensitivity to nuanced user perceptions, especially among users with varying levels of digital literacy, which is often observed within Vietnamese small and medium-sized enterprises (SMEs) [31]. Third, empirical studies have consistently shown that combining TAM and UTAUT can improve predictive power [32-35]. This integration enables cross-validation of overlapping constructs while preserving their distinct operational interpretations, consequently offering a more robust explanation of technology acceptance and enhancing its explanatory power compared to using either model in isolation [33]. Furthermore, while Attitude toward Organizational Adoption (ATT) is conceptualized as a central mediating factor, the model also retains direct paths from Technology (TECH), Organization (ORG), and Environment (ENV) to E-Bidding Effectiveness. This structure is crucial for reflecting the heterogeneous realities of implementation in Vietnam's construction sector. For instance, robust technological infrastructure (TECH) or external technical service contracts can directly improve bid outcomes without requiring high levels of internal adaptation. Similarly, strong leadership commitment and streamlined internal processes (ORG) might bypass attitudinal constraints to achieve operational effectiveness directly. From the environmental side (ENV), policy incentives or donor-enforced compliance can directly drive effective outcomes irrespective of internal readiness, such as government-mandated training enhancing e-bidding results without necessarily transforming organizational attitudes [36-39]. Thus, including these direct effects acknowledges that some firms achieve success due to structural or contextual

advantages, indicating not all pathways to success are fully mediated by ATT. This model structure aligns with prior empirical studies that found mixed patterns of mediation and partial mediation in technology adoption models, especially prevalent in developing and semi-coercive contexts [36-39]. Therefore, this integration is not redundant; rather, it enhances the model's robustness and adaptability in contexts where user perception and implementation pathways vary significantly due to institutional mandates and organizational readiness.

In conclusion, the integrated model represents not only a theoretical advancement in identifying influential factors but also introduces a systematic approach for improving ECT effectiveness in the construction sector - an industry shaped by complex technical, legal, and cultural dynamics. This framework lays the foundation for applied research and digital transformation policy design in the post-2025 construction landscape.

#### **Pilot Testing Plan:**

To validate the proposed theoretical model, a pilot study is planned as a follow-up to this conceptual research. The pilot will involve 30 to 50 construction enterprises participating in Vietnam's national e-bidding system, selected across three representative provinces and enterprise sizes (small, medium, and large).

The survey instrument will operationalize model constructs using 5-point Likert-scale items adapted from prior validated studies (Davis, 1989 [17]; Venkatesh et al., 2003 [2003]; Zhu et al., 2006 [16]). Data collected will be analyzed using Exploratory Factor Analysis (EFA) to examine construct dimensionality, followed by preliminary structural modeling to explore path relationships.

This empirical phase will help confirm construct reliability and refine the proposed framework before broader application. It also provides a practical basis for policymaking and further academic inquiry.

## **7. Conclusion and Research Implications**

This study proposed and analyzed an integrated TOE - TAM - UTAUT theoretical framework to explain the factors influencing the effectiveness of electronic construction tendering (ECT) implementation in Vietnam. By synthesizing foundational models with contextual realities, the framework not only clarifies the roles of technological, organizational, and environmental factors but also highlights the significance of user behavior perception in shaping the adoption of e-procurement systems. Unlike prior studies that often examined these factors in isolation or focused narrowly on technical aspects, the proposed integrated model offers a holistic and systematic perspective.

Key components - such as IT infrastructure, human resource capability, organizational commitment, regulatory frameworks, and social influence - are considered within a multidimensional structure. This provides a strong theoretical basis for future empirical validation using quantitative methods.

In the context of Vietnam's ongoing administrative reforms and national digital transformation, especially within the construction and public investment sectors, the study's findings carry substantial practical implications. Policy development should prioritize three interrelated areas.

From a policy perspective, the findings suggest that interventions should be differentiated by enterprise type. For SMEs in rural areas, targeted support such as subsidized training, simplified user interfaces, and mobile-based access to the ECT platform could mitigate access barriers. For large firms, integration incentives between ECT and ERP systems should be considered. Policymakers must also stabilize the regulatory framework to reduce compliance uncertainty, especially for firms in remote provinces.

1. Upgrading infrastructure and ensuring cybersecurity for the e-bidding system;
2. Enhancing the skills of procurement personnel and establishing effective technical support mechanisms;
3. Refining legal frameworks to promote clarity and consistency for enterprises and regulators.

Furthermore, the proposed framework can serve as an evaluation tool for assessing ECT readiness at the ministerial, provincial, or enterprise level. It offers a structured foundation for analyzing, benchmarking, and tailoring improvement strategies based on enterprise scale or geographical location. This direction is crucial for optimizing public investment efficiency, promoting fair competition, and enhancing transparency in Vietnam's construction sector.

Future research should focus on empirically testing the proposed model through field surveys and applying advanced quantitative methods such as Structural Equation Modeling (SEM) or Partial Least Squares SEM (PLS-SEM) to determine the relative influence of each factor group. Comparative studies across firms of different sizes, regions, and levels of public administration will also help clarify contextual differences in ECT implementation across Vietnam.

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## Declarations

**Conflict of Interest:** No potential conflict of interest was reported by the authors.

**Declaration of Generative AI in Scientific Writing:** During the preparation of this work, the authors used ChatGPT in order to assist the writing process more naturally. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

## Author Contribution

*The authors confirm their contribution to the paper as follows: **study conception and design:** Nguyen Quoc Toan; **data collection:** Nguyen Thi Thu Hien; **analysis and interpretation of results:** Nguyen Quoc Toan, Nguyen Thi Thu Hien and Tran Trung Kien; **draft manuscript preparation:** Nguyen Quoc Toan. All authors reviewed the results and approved the final version of the manuscript.*

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