



EVALUATING E-TENDERING READINESS IN MALAYSIAN PUBLIC-PRIVATE PARTNERSHIPS PROCUREMENT: A PLS-SEM APPROACH

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Abstract

The digitalisation of public procurement has accelerated the adoption of electronic tendering (e-tendering), particularly in Public-Private Partnership (PPP) procurement. However, many public organisations remain inadequately prepared for effective implementation. This study examines multidimensional e-tendering readiness in Malaysian PPP procurement by evaluating people, operational, technological, organisational, service provider, and legal-security dimensions. Data were collected from 121 government officers involved in Malaysian PPP procurement and analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM). The results show that People factors ($\beta = 0.170$, $p = 0.020$) and Operational factors ($\beta = -0.458$, $p < 0.001$) significantly influence readiness, whereas Technology, Work Environment, Service Provider, and Legal and Security factors do not exert statistically significant direct effects. Overall, the findings indicate that human capability and process design are more decisive than technology availability alone. The paper offers a context-specific readiness model based on the perceptions of Malaysian government officers involved in PPP procurement and provides practical implications for public agencies seeking to strengthen digital tendering reform.

Keywords: e-tendering, public-private partnership, PPP procurement, readiness, digital procurement, PLS-SEM

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INTRODUCTION

Public procurement is increasingly recognised as a strategic state function that transforms public resources into infrastructure, services, market opportunities, and public value. Procurement systems are increasingly evaluated by their ability to strengthen transparency, accountability, traceability, and implementation effectiveness rather than cost efficiency alone (Khorana et al., 2024; OECD, 2025). Given its scale and role in service delivery, procurement quality directly influences public trust, governance performance, and project outcomes (OECD, 2025).

In Malaysia, Public-Private Partnerships have become an important route for infrastructure development when governments must balance fiscal discipline with long-term service obligations. PPP arrangements combine private financing, technical expertise, and lifecycle management but involve complex approvals, legal due diligence, lengthy documentation, and intensive public scrutiny over risk allocation and value for money. As a result, the tendering stage is particularly critical because weaknesses at this point can affect competition, confidence, contract quality, and downstream implementation (Al Saadi & Abdou, 2024; Mat Aron et al., 2024; Wang et al., 2018).

Digital procurement and e-tendering address many weaknesses of traditional procurement systems. In Malaysia, e-procurement has been discussed for more than a decade as part of public sector modernisation, with earlier studies already identifying challenges related to organisational adaptation, user readiness, and implementation capability (Aman & Kasimin, 2011; Kaliannan, 2011; Kaliannan & Raman, 2009). Recent studies show that e-tendering improves publication, document access, clarification management, submission control, and audit trails while reducing paper-based documentation and improving consistency in procurement communication (Hochstetter et al., 2023; Khorana et al., 2024). However, implementation still depends on technical capability, user readiness, institutional support, policy consistency, and procedural adaptation, particularly in construction and PPP procurement settings (Inusah et al., 2025; Mat Aron et al., 2024).

The key issue, therefore, is readiness. Organisations may have digital platforms in place but still struggle to use them effectively if staff capability is weak, procedures remain cumbersome, or trust in digital processes is limited. This problem is especially visible in developing procurement systems, where the gap between formal reform and day-to-day practice can be substantial. In the Malaysian PPP context, e-tendering continues to face implementation issues, making it necessary to assess readiness among the public-sector actors responsible for procurement delivery (Mat Aron et al., 2024).

Accordingly, this paper examines six dimensions of e-tendering readiness among government officers involved in PPP procurement in Malaysia:

People, Operational, Technology, Work Environment, Service Provider, and Legal and Security factors. Using questionnaire survey data and PLS-SEM, the paper identifies which dimensions matter most, how they influence readiness, and why some factors that appear important in principle do not emerge as direct predictors in practice. It contributes by offering a multidimensional lens for assessing readiness, providing empirical evidence from Malaysian PPP procurement, and translating the findings into practical implications for agencies seeking to strengthen digital tender implementation.

LITERATURE REVIEW

Recent literature positions digitalisation as a core element of public sector modernisation. E-procurement is increasingly recognised as both an efficiency tool and a governance mechanism that strengthens transparency, accountability, data integration, and decision quality. Mavidis and Folinas (2022) describe this transition as a shift towards intelligent procurement characterised by interoperability, analytics, and strategic technology use, while Bosio et al. (2023) emphasise that its benefits depend on supportive institutional conditions.

Recent studies consistently demonstrate that digital procurement enhances transparency, accountability, auditability, and procurement integrity through improved traceability and electronic documentation (Ahmad et al., 2021; Hochstetter et al., 2023; Khorana et al., 2024; Sanda et al., 2024).

Digital procurement also improves organisational efficiency through faster tender circulation, easier document access, greater standardisation, and stronger process control. However, successful implementation depends on staff capability, managerial support, institutional readiness, and effective process integration (Afolabi et al., 2019; Muhwezi et al., 2023; Waci et al., 2024). Nevertheless, implementation capability, organisational resistance, and process complexity remain major barriers, often outweighing technological limitations (Sakutemba et al., 2024; Inusah et al., 2025; Yevu et al., 2021).

PPP procurement is inherently more complex than conventional procurement because it involves long-term risk allocation, sophisticated financial and legal structures, project-specific technical requirements, and multi-stage evaluations. Studies consistently identify institutional capability, governance, legal continuity, stakeholder commitment, and disciplined monitoring as critical success factors (Osei-Kyei & Chan, 2021; Casady et al., 2023; Alsamarraie et al., 2025; Ojelabi et al., 2025). Emerging technologies, including Industry 4.0, smart contracts, machine learning, and digital contractor prequalification, further strengthen procurement transparency and efficiency (Alaloul et al., 2019; Sava & Dragoş, 2022; Demeter et al., 2025; Abouahmed et al., 2026).

Taken together, the literature shows that e-tendering readiness is multidimensional. It depends not only on the availability of digital tools, but also

on whether organisations possess the skills, structures, routines, and confidence needed to use those tools effectively. Building on this synthesis, the present study conceptualises six readiness dimensions: People, Operational, Technology, Work Environment, Service Provider, and Legal and Security. People factors represent staff competence, confidence, knowledge, and resource adequacy. Operational factors reflect procurement process complexity, transparency, enforceability, and data integrity. Technology factors encompass system reliability, integration, infrastructure, compatibility, implementation knowledge, and cost considerations. Work Environment factors capture leadership support, organisational culture, strategic clarity, flexibility, awareness, and internal priorities. Service Provider factors represent supplier readiness, interoperability, data sharing, and collaboration. Legal and Security factors include anti-corruption safeguards, electronic signature enforceability, ownership issues, case law, and confidence in digital legal controls. The literature therefore suggests that successful PPP e-tendering depends on alignment across these dimensions rather than technology alone.

Based on the literature, six hypotheses were developed. H1 proposes that People factors positively influence e-tendering readiness, H2 that Operational factors significantly influence readiness, and H3–H6 that Technology, Work Environment, Service Provider, and Legal and Security factors positively influence e-tendering readiness.

RESEARCH METHODOLOGY

This study adopted a quantitative research approach to evaluate the determinants of e-tendering readiness within the context of Malaysian Public-Private Partnership procurement. The research framework comprised seven latent constructs, namely People, Operational, Technology, Work Environment, Service Provider, Legal and Security, and E-Tendering Readiness. These constructs were incorporated into a structured questionnaire designed to capture respondents' background information, involvement in PPP procurement activities, and perceptions of readiness-related factors.

Measurement items were adapted from established literature, refined for the Malaysian PPP procurement context, and reviewed for clarity, content validity, and contextual appropriateness before data collection. All constructs were measured using a five-point Likert scale (1 = Strongly Disagree; 5 = Strongly Agree). A five-point Likert scale was adopted because it is widely used in organisational research and is suitable for measuring perceptual constructs in Partial Least Squares Structural Equation Modelling (PLS-SEM) (Hair et al., 2021).

Data were collected through an online questionnaire, providing flexibility, standardisation, and efficient data collection for geographically

dispersed respondents (Evans & Mathur, 2018; Wright, 2005). Data were analysed using IBM SPSS Statistics and SmartPLS 4 for descriptive and PLS-SEM analyses.

Purposive sampling was used because the study required informed respondents who were directly involved in PPP procurement or sufficiently familiar with PPP project processes. Accordingly, the study targeted officers at Grade 41 and above who were involved in procurement planning, tender administration, project coordination, evaluation, or related PPP decision-making functions. The study population comprised officers from PPP-related units across selected Malaysian ministries and agencies. The estimated population of 163 officers was identified from internal organisational directories of the participating ministries and agencies, which were used to identify officers involved in PPP-related procurement and project development functions. Based on this population, the minimum sample size was 113 respondents according to Krejcie and Morgan (1970). Of 150 questionnaires distributed, 124 were returned and 121 were valid for analysis, yielding an 80.6% response rate.

Figure 1 presents the G*Power output used to verify sample adequacy. The analysis indicated a minimum sample size of 107 cases for six predictors. The final sample of 121 responses exceeded this requirement and was therefore adequate for PLS-SEM analysis.

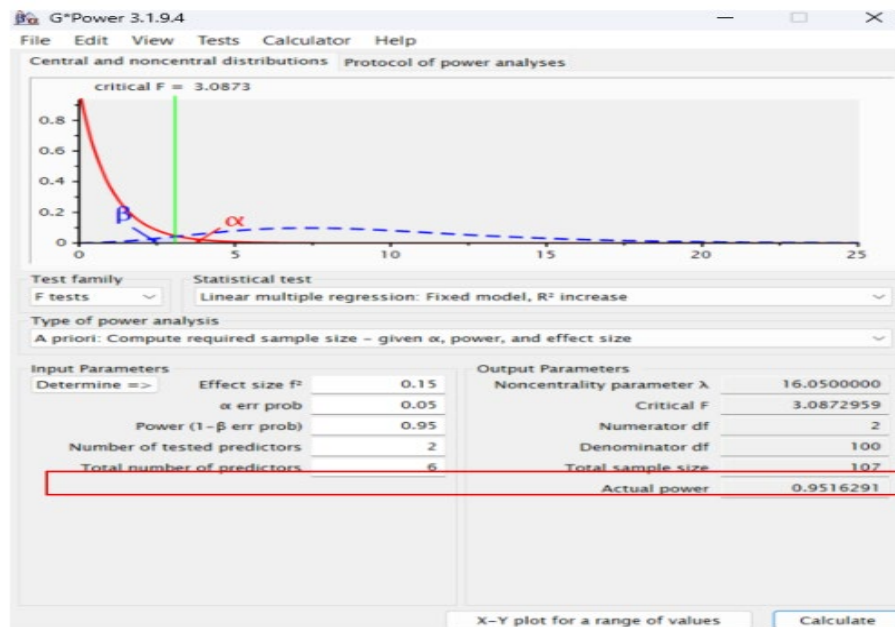


Figure 1: G*Power output for minimum sample size determination

The questionnaire comprised multi-item indicators representing the seven proposed constructs. Measurement items for each construct were adapted from established literature and refined for the Malaysian PPP context.

Prior to analysis, data were screened for completeness, consistency, and coding accuracy. Measurement items were reviewed to ensure consistent coding direction across the seven latent constructs. Where applicable, negatively worded items were reverse-coded so that higher scores represented higher construct levels. The coding procedure was verified during data screening to ensure alignment with each construct's conceptual definition and minimise coding-related bias during structural model estimation.

Descriptive analysis was conducted using SPSS, while structural relationships were assessed using PLS-SEM in SmartPLS 4. PLS-SEM was selected because it suits complex exploratory models, moderate samples, non-normal data, and prediction-oriented analysis involving multiple latent constructs (Hair et al., 2021, 2019; Henseler et al., 2022; Sarstedt et al., 2022). The analysis assessed indicator reliability, internal consistency, convergent validity, discriminant validity, structural path coefficients, collinearity, and explained variance. The structural model followed the recommended PLS-SEM procedure, covering collinearity (VIF), explanatory power (R^2), effect size (f^2), predictive relevance (Q^2), and bootstrapping-based hypothesis testing (Hair et al., 2021).

ANALYSIS AND DISCUSSION

The respondent profile indicates that the sample was suitable for the study objectives. Most respondents were aged 41–50, had relevant experience, and were directly involved in PPP procurement. Their academic and professional backgrounds suggest that responses reflected informed professional judgment rather than general opinion.

Respondents also reported substantial exposure to PPP-related procurement, including tender processes and different project types. These characteristics support the adequacy of the dataset for analysing e-tendering readiness in PPP procurement. Table 1 summarises the respondent profile.

Table 1: Respondent profile summary

Variable	Key result
Gender	Female 52%; Male 48%
Age	20–30 years 2%; 31–40 years 21%; 41–50 years 51%; 51–60 years 26%
Experience	1–3 years 20%; 4–6 years 30%;

Variable	Key result
	7–9 years 33%; >10 years 17%
Organization type	Government 100%
Procurement involvement	Often 44%; Sometimes 38%; Rarely 18%
Education	Bachelor 61%; Master 37%; PhD 2%

As shown in Table 1, the sample represents a mature and professionally relevant respondent group. The respondents' age, experience, and procurement involvement indicate sufficient familiarity with the procedural, administrative, and strategic aspects of PPP procurement, strengthening the credibility of the analysis.

Prior to evaluating the structural relationships, the measurement model was assessed to establish indicator reliability, internal consistency reliability, convergent validity, and discriminant validity. Following the guidelines of Hair et al. (2021), the assessment included indicator loadings, Cronbach's Alpha, Composite Reliability (CR), Average Variance Extracted (AVE), and the Heterotrait–Monotrait Ratio (HTMT). The results indicate that all constructs satisfied the recommended thresholds, confirming that the measurement model was reliable and valid for subsequent structural model assessment.

Table 2: Reliability and Convergent Validity

Construct	Cronbach's Alpha	Composite Reliability	AVE	Assessment
People	0.937	0.935	0.743	Accepted
Operational	0.958	0.956	0.681	Accepted
Technology	0.949	0.948	0.701	Accepted
Work Environment	0.945	0.942	0.673	Accepted
Service Provider	0.881	0.879	0.648	Accepted
Legal & Security	0.933	0.933	0.713	Accepted
Readiness	0.932	0.933	0.706	Accepted

Table 2 shows that all constructs satisfied the recommended thresholds for internal consistency and convergent validity. Cronbach's Alpha and Composite Reliability exceeded 0.70, while AVE values were above 0.50, confirming that the constructs were measured reliably and were suitable for structural model analysis.

Table 3: Discriminant Validity Assessment using HTMT

Construct	LS	PP	PR	RE	SP	TE	WE
LS	—						
PP	0.454	—					
PR	0.663	0.581	—				
RE	0.626	0.560	0.635	—			
SP	0.278	0.489	0.472	0.353	—		
TE	0.583	0.408	0.772	0.774	0.350	—	
WE	0.589	0.448	0.772	0.693	0.423	0.862	—

Discriminant validity was assessed using the Heterotrait–Monotrait Ratio (HTMT). As shown in Table 3, all values were below the recommended threshold of 0.90 (Hair et al., 2021), confirming that each construct represents a distinct dimension of organisational readiness for e-tendering implementation.

The measurement model demonstrated satisfactory reliability and validity, with most factor loadings exceeding 0.70. Particularly strong loadings were observed for the People construct, especially for staff preparedness, resource adequacy, and e-procurement knowledge. Selected high-loading indicators are presented in Table 4.

Table 4: Selected construct diagnostics from exploratory measurement assessment

Construct	High-loading items	Interpretation
People	PP01 = 0.962; PP05 = 0.850; PP02 = 0.722	Strong human-capability signal
Operational	PR05 = 0.898; PR02 = 0.869; PR07 = 0.868; PR10 = 0.735	Process integrity and transparency are salient
Technology	TE01 = 0.902; TE04 = 0.828; TE08 = 0.785	Infrastructure and integration matter descriptively
Work Environment	WE02, WE03, WE04, WE07, WE11, WE14 all strong	Leadership and culture perceived as important
Service Provider	SP04 = 0.874	Marketplace readiness recognized
Legal and Security	LS11 = 0.934	Corruption and legal clarity remain salient issues

Table 4 shows that several indicators performed strongly across the People, Operational, Technology, Work Environment, Service Provider, and Legal and Security constructs. The People and Operational dimensions recorded the strongest loadings, indicating that staff capability, procedural standards,

document integrity, and transparency are central to e-tendering readiness. These findings support the multidimensional nature of readiness beyond technological capability.

Figure 2 illustrates the factor loading pattern across the study constructs. The figure confirms the multidimensional nature of the model, with particularly strong loadings for the People, Operational, Technology, and Work Environment constructs.

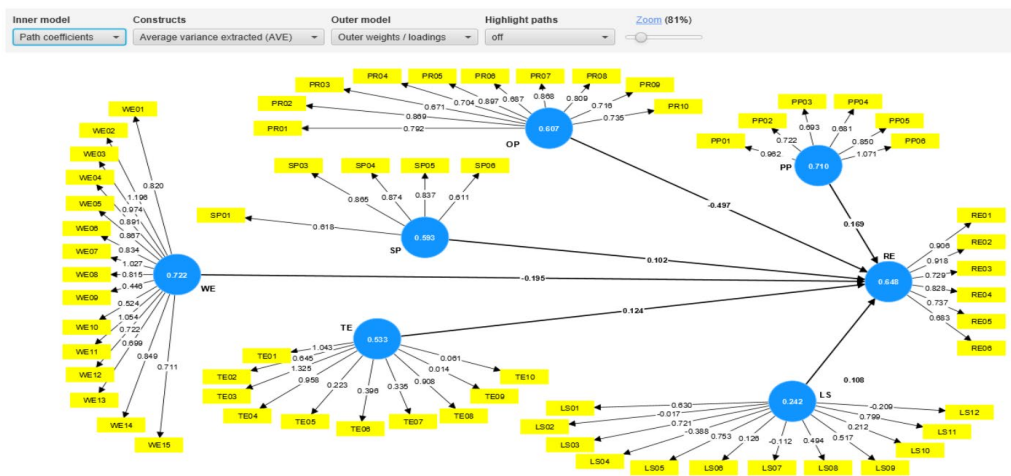


Figure 2: Factor loading and variance distribution across PPP e-tendering readiness constructs

Operational factors showed strong loadings for process standards, document integrity, data transmission, and transparency. Technology also demonstrated satisfactory measurement, particularly for cost implications, system reliability, and integration. The Work Environment, Service Provider, and Legal and Security constructs likewise exhibited acceptable indicator performance, supporting their relevance to organisational readiness.

Following measurement model validation, the structural model was assessed to examine the explanatory capability of the proposed framework. Consistent with Hair et al. (2021), structural model assessment included collinearity (VIF), explanatory power (R^2), effect size (f^2), predictive relevance (Q^2), and bootstrapping. In this study, the analysis focused on VIF, R^2 , and bootstrapping using SmartPLS 4.

Table 5: Structural model assessment

Assessment	Result	Threshold
Maximum VIF	2.44	>0.50
explanatory power (R^2),	0.543	>0
predictive relevance (Q^2)	0.361	<5.0
bootstrapping	5,000	

Table 5 summarises the structural model assessment. The coefficient of determination ($R^2 = 0.543$) indicates that the six readiness dimensions jointly explained 54.3% of the variance in E-Tendering Readiness, representing a moderate level of explanatory power. Furthermore, all predictor constructs recorded Variance Inflation Factor (VIF) values below the recommended threshold of 5.0, indicating that multicollinearity was not a concern. The value (Q^2) exceeded zero, indicating that the model possesses predictive relevance. The significance of the structural relationships was subsequently evaluated using the bootstrapping procedure in SmartPLS 4 based on the estimated path coefficients and corresponding significance values.

The structural model identified People and Operational factors as the only significant predictors of e-tendering readiness. People factors positively influenced readiness, whereas Operational factors showed a significant negative effect, suggesting that conventional paper-based procedures may hinder end-to-end digital implementation. The structural path estimates are presented in Table 6.

Table 6: Bootstrapping results

Path	Beta	t-value	p-value	Decision
People -> Readiness	0.170	2.34	0.020	Supported
Operational -> Readiness	-0.458	5.11	<0.001	Supported
Technology -> Readiness	0.129	0.73	0.465	Not supported
Work Environment -> Readiness	0.108	1.51	0.132	Not supported
Service Provider -> Readiness	-0.167	1.06	0.292	Not supported
Legal and Security -> Readiness	0.061	0.38	0.702	Not supported

Table 6 shows that People factors are the strongest positive predictor of e-tendering readiness, whereas Operational factors have a significant negative effect. The remaining constructs were not significant direct predictors, although they remain important enabling conditions.

Although Technology, Work Environment, Service Provider, and Legal and Security factors are widely recognised as important determinants of digital

procurement, their non-significant direct effects suggest that they function primarily as enabling conditions rather than immediate drivers of e-tendering readiness. In the Malaysian PPP context, these dimensions are relatively well established across public organisations, resulting in limited variation in respondents' perceptions once People capability and Operational readiness are considered simultaneously. This interpretation is consistent with previous studies showing that organisational resistance and process complexity often exert stronger influences on digital procurement implementation than technology alone (Inusah et al., 2025). Leadership support and supplier readiness may therefore contribute indirectly through staff capability, process improvement, and ecosystem maturity (Duong et al., 2024; Fayos et al., 2022; Herrmann & Cobo Martín, 2025), while legal and security frameworks remain essential for institutional trust and procurement integrity (Sava & Dragoş, 2022; Aboelazm et al., 2025). These dimensions may therefore exert indirect, mediating, or moderating effects that warrant further investigation.

Overall, the six readiness dimensions capture an important part of the factors shaping e-tendering readiness among government officers involved in Malaysian PPP procurement, while the collinearity assessment confirms stable model estimates. People factors emerged as the strongest positive predictor of e-tendering readiness, highlighting the importance of staff capability in digital procurement reform. Officers involved in contract preparation, evaluation, compliance, and clarification management require adequate knowledge, resources, and confidence to support successful implementation, consistent with Afolabi et al. (2019) and Kissi et al. (2025).

Because all measurement items were verified during data preparation, the negative relationship between Operational factors and e-tendering readiness reflects a genuine empirical finding rather than reverse coding or measurement inconsistency. The finding suggests that existing procurement procedures remain insufficiently aligned with digital workflows despite organisational commitment to reform.

PPP procurement processes are often highly formalised to ensure accountability and legal defensibility. However, fragmented approvals, excessive documentation, sequential endorsement processes, and continued reliance on manually signed or hard-copy documents reduce the efficiency of end-to-end digital workflows (Mat Aron et al., 2024; Inusah et al., 2025; World Bank, 2011). These findings suggest that operational procedures should be redesigned to preserve governance while improving digital usability.

The negative effect should therefore not be interpreted as evidence that operational management is inherently detrimental to e-tendering readiness. Instead, it reflects a mismatch between traditional procurement procedures and the operational requirements of digital procurement systems. Although strong

operational controls remain essential for accountability and transparency, excessive procedural complexity may reduce organisational flexibility and delay digital implementation, consistent with Yevu et al. (2021), Sakutemba et al. (2024), and Inusah et al. (2025).

The insignificance of Technology factors should be interpreted carefully. It does not mean that technology is unimportant; rather, it suggests that technology may already be a background enabling condition in the present sample. Readiness differences therefore appear to depend less on whether systems are available and more on whether people and procedures can use them effectively. Because e-procurement initiatives have been part of Malaysia's public sector modernisation for over a decade, basic technological infrastructure is likely normalised among the experienced Grade 41 and above officers handling these projects. This helps explain why the mere acquisition of platforms does not automatically produce transformation.

Taken together, the findings point to a socio-technical understanding of readiness. E-tendering reform in PPP procurement should not be treated as an isolated technology deployment. Instead, it requires capable people, digitally compatible procedures, and implementation governance that reflects the complexity of PPP transactions. Public agencies can procure systems, but readiness itself must be built through training, process simplification, workflow redesign, and confidence in digital controls.

These findings are also important at the policy level. Ministries and agencies pursuing e-tendering in PPP settings should begin with readiness diagnostics before mandating platform use across complex projects. They should identify where the process architecture is likely to create friction and invest in function-specific training rather than generic awareness programmes. Officers involved in drafting terms, uploading tender packs, managing clarifications, checking compliance, and supporting evaluation committees require different competencies, and a single training module is unlikely to be sufficient.

Overall, the findings indicate that successful digital procurement reform depends on addressing organisational capability and legacy processes rather than technology alone. Public agencies should undertake readiness assessments before implementing new e-tendering systems, procurement officers should strengthen digital competencies through continuous professional development, and system providers should design user-centred platforms that integrate seamlessly with procurement workflows. Accordingly, the proposed readiness model offers a practical diagnostic framework for prioritising improvement initiatives and monitoring digital procurement transformation.

CONCLUSION

This paper examined e-tendering readiness in Public-Private Partnership procurement in Malaysia using questionnaire survey data and PLS-SEM analysis. Readiness was conceptualised as a multidimensional construct comprising People, Operational, Technology, Work Environment, Service Provider, and Legal and Security factors. The findings indicate that People positively and significantly influenced e-tendering readiness, whereas Operational factors had a significant negative effect. Although Technology, Work Environment, Service Provider, and Legal and Security factors are conceptually important, they were not significant direct predictors in the proposed model. The model explained a meaningful proportion of variance in organisational readiness among government officers involved in Malaysian PPP procurement, indicating that the proposed framework provides a useful basis for understanding public-sector readiness for digital procurement reform. The findings should, however, be interpreted within the context of the study population and should not be generalised to private-sector organisations, concessionaires, or other procurement stakeholders without further empirical validation.

Overall, the proposed readiness model provides a practical evidence-based framework that may assist Malaysian public agencies in systematically assessing organisational preparedness before undertaking digital procurement transformation initiatives.

LIMITATIONS AND FUTURE RESEARCH

This study has several limitations. First, the respondents were all public-sector officers, so the findings mainly reflect readiness from the government's point of view. The views of other important parties, such as bidders, consultants, concessionaires, and technology providers, were not included directly. Future studies should involve these groups so that e-tendering readiness can be assessed more fully across the entire procurement ecosystem, and not only from an internal government perspective. Accordingly, the findings should be interpreted as reflecting the perceptions of government procurement practitioners and should not be generalised to the wider PPP ecosystem without further empirical evidence from other stakeholder groups.

Second, this study used a cross-sectional design, which means the data were collected at only one point in time. Because of this, the study cannot show how readiness may change before and after new policies, implementation stages, or specific improvement efforts. Future research could use a longitudinal approach to examine whether training, process improvements, or legal and policy changes lead to measurable improvements in readiness over time. Comparative studies across sectors and countries would also be useful to identify which barriers are specific to a particular context and which are more widely shared.

Future research should also explore the role of emerging technologies in PPP tendering. These may include artificial intelligence to support evaluation, blockchain to strengthen document security, smart contracts to improve enforceability, and advanced analytics to detect procurement risks. In addition, future studies could examine issues such as AI ethics, sustainable procurement measurement, procurement data analysis, and public value. This would help broaden future readiness models so that they address not only adoption, but also integrity, sustainability, resilience, and long-term governance performance.

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Received: 12th June 2026. Accepted: 14th June 2026