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Digital Divide, Cybersecurity Risk Perceptions, and Trust in Malaysian Government E-Participation: A PLS-SEM and fsQCA Analysis

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Abstract: Government digital platforms have expanded rapidly across Southeast Asia, yet citizen e-participation remains persistently low. This study examines how the digital divide and cybersecurity-related risk perceptions are associated with e-participation and perceived platform effectiveness in Malaysia's government digital platform context, and whether institutional, technology, and procedural trust moderate risk-outcome associations. Drawing on a stratified quota sample of n = 339 Malaysian government digital platform users, the study employs a complementary dual-method design: Partial Least Squares Structural Equation Modelling (PLS-SEM) for variable-oriented analysis and fuzzy-set Qualitative Comparative Analysis (fsQCA) for configurational analysis. PLS-SEM path estimates show positive associations of physical access and digital skills with both outcomes, while all three cybersecurity-related risk perceptions—privacy risk, security risk, and misinformation risk—show significant negative associations with both. None of the eighteen trust × risk interactions tested survives correction for multiple testing; within this design, trust is more consistently observed as a positive direct correlate of e-participation than as a demonstrable conditional moderator. fsQCA identifies physical access as the only necessary condition for both outcomes under the reported calibration and reveals nine equifinal configurations sufficient for above-average participation within this user sample, all resting on an access-and-skills base and differentiated by core combinations of low perceived risk, affordability, and trust; configurations associated with low participation combine elevated risk perceptions with absent trust. These findings advance understanding of digital governance inclusivity, identify one necessary condition and several sample-relative sufficient configurations associated with citizen digital engagement, and offer targeted policy guidance for Malaysian e-governance.

Keywords: e-participation; digital divide; cybersecurity perceptions; trust; PLS-SEM; fsQCA; Malaysia

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1. Introduction

Government digital platforms represent one of the most visible expressions of the democratic promise of the internet—a technology that could, in principle, reduce the barriers of geography, time, and institutional gatekeeping that have historically constrained citizen participation in governance. Malaysia's investment in official portals, digital service platforms, e-complaint systems, consultation channels, and official social media accounts illustrates both the ambition and the challenge: digital channels for citizen input have expanded, yet participatory uptake remains persistently low. The Malaysian Communications and Multimedia Commission's Internet Users Survey indicates that Malaysian internet users engage government online channels primarily for information retrieval or service transactions rather than for active civic engagement (MCMC, 2024), and city-level e-participation evidence from Putrajaya and Petaling Jaya points in the same direction (Lim & Yigitcanlar, 2022). Understanding why this gap persists—and which combinations of conditions are associated with participatory engagement—is both a theoretical and a governance priority.

Three overlapping streams of scholarship are relevant to this question. First, digital divide theory identifies material access, digital skills, and affordability as structural preconditions for digital civic engagement (Van Dijk, 2020). The first-level divide—physical access to devices and connectivity—remains relevant in Malaysia despite expanding broadband infrastructure, particularly in rural and lower-income contexts. The second-level divide—skills and quality of use—may be equally consequential for participation in complex government consultation processes that require navigational competency beyond basic internet use. Second, cybersecurity risk perception research documents how privacy concerns, security anxieties, and misinformation fears independently suppress willingness to share personal information or opinions with digital institutions (Bélanger & Crossler, 2011; Chesney & Citron, 2019; Alzahrani et al., 2017). In Malaysia, where government data governance has faced public scrutiny and where social media has become a major channel for both official communication and political disinformation, these perceptions may constitute independent barriers to participation beyond what the digital divide literature typically captures. Third, trust scholarship has theorised institutional, technology, and procedural trust as moderating boundary conditions that shape how structural and perceptual barriers translate into behaviour (Abdulkareem & Mohd Ramli, 2022; Norris, 2011).

Despite the relevance of all three frameworks, they have rarely been integrated in a single empirical study, their interactions have rarely been tested with configurational methods capable of revealing which combinations of conditions are jointly sufficient for participation, and their combined application to non-voting e-participation in developing and middle-income country contexts remains limited. Most existing studies test either digital divide or trust effects on e-government adoption, rarely incorporating cybersecurity risk perceptions as independent constructs or employing set-theoretic methods that can identify asymmetric and equifinal pathways. Dual PLS-SEM/fsQCA designs have, however, begun to appear in e-government participation research, including in Southeast Asia (Hutahaean et al., 2023); the value of the present study therefore lies not in the method combination as such but in the constructs and conditions to which it is applied.

This study addresses these gaps through three specific contributions. First, it integrates digital divide dimensions (physical access, digital skills, affordability), cybersecurity-related risk perceptions (privacy risk, security risk, misinformation risk), and trust dimensions (institutional, technology, procedural) within a single structural model, tested with PLS-SEM on a sample of Malaysian government digital platform users (n = 339). Second, it uses fsQCA to identify necessary conditions and sample-relative sufficient configurations associated with above-average and low e-participation under explicit calibration choices. Third, it disaggregates cybersecurity-related perceptions into three distinct facets and shows that, within this dataset and operationalisation, misinformation risk has the largest negative association with perceived platform effectiveness.

The study situates its empirical findings within the broader debate on participatory governance quality and the conditions under which government digital infrastructure produces democratic value rather than merely nominal participation channels. In Malaysia's governance context—characterised by a centralised administrative tradition and historically limited space for formal citizen input into policy processes—the design of e-participation infrastructure represents both an opportunity and a test: an opportunity to expand the legitimacy base of public decision-making, and a test of whether digital channels can translate latent civic engagement potential into active participatory practice. Malaysia occupies a theoretically distinctive position: a rapidly digitalising middle-income economy with high smartphone penetration but significant urban–rural and income-based digital inequality, a governance system that is formally democratic but operationally centralised, and a rapidly evolving cybersecurity landscape shaped by both state and non-state actors.

The remainder of the article is structured as follows: Section 2 develops the theoretical framework and hypotheses; Section 3 describes the research design and analytical approach; Section 4 presents the results; Section 5 discusses the findings in relation to theory and practice; Section 6 concludes.

2. Theoretical Background and Hypotheses

2.1 Integrating Digital Divide, Cybersecurity Risk, and Trust

The theoretical integration motivating this study reflects a recognition that e-participation barriers are multi-layered and interactive. Digital divide theory has progressively moved from a focus on binary access (have/have-not) toward a more nuanced understanding of differential engagement quality (Van Dijk, 2020; Robinson et al., 2015). In the e-participation context, even citizens who have internet access may face second-level skill deficits that prevent meaningful engagement with government consultation mechanisms, or affordability constraints that make the ongoing data costs of digital civic engagement financially burdensome relative to perceived benefits.

For a study of e-democracy, what makes e-participation worth explaining is not usage as such but its democratic meaning: consultative and expressive channels contribute to democratic legitimacy only insofar as citizen input is solicited, processed, and visibly answered. Two properties of the citizen–state feedback loop are therefore central to the framework developed below. The first is responsiveness—whether submissions demonstrably enter decision processes; in the present model, procedural trust captures the citizen-side perception of precisely this property. The second is the distinction between symbolic and meaningful participation: channels that collect input without consequence may depress rather than build engagement (Macintosh & Whyte, 2008). These considerations motivate treating participation behaviour directed at public issues—rather than platform adoption or service use—as the outcome of interest, and they frame the later interpretation of the comparatively low procedural-trust levels observed in this sample.

Cybersecurity risk perceptions constitute a distinct and underexplored layer of barriers. Misinformation risk—the perception that government digital channels are compromised by manipulated, algorithmically amplified, or AI-generated content—has received particular attention following the proliferation of deepfake technologies and coordinated influence operations (Chesney & Citron, 2019; Vosoughi et al., 2018). The argument that these perceptions operate independently of and additively with access and skills barriers motivates their explicit inclusion as distinct predictors in the structural model.

Trust dimensions have been theorised as moderating variables that condition how perceived risk translates into behaviour. However, empirical evidence for robust trust moderation is mixed (Abdulkareem & Mohd Ramli, 2022), and the present study tests the moderating role while also allowing for the possibility that trust operates primarily as a direct positive predictor—a more parsimonious theoretical positioning consistent with diffuse support models in political science (Norris, 2011).

2.2 Digital Divide Dimensions and E-Participation

Physical access to devices and reliable internet connectivity has been identified as the foundational first-level precondition for digital civic engagement. In Malaysia, while smartphone penetration has expanded substantially, significant variation in connection stability and reliability persists between urban and rural areas and across income groups (Devisakti et al., 2024). The study hypothesises that higher physical access positively predicts both e-participation behaviour and perceived platform effectiveness (H1a).

Digital skills—the competency to navigate, evaluate, and engage with digital content and services—constitute the second-level divide and may be particularly consequential for e-participation. Studies in ASEAN member states consistently show digital competency gaps as a critical moderating factor in e-government programme success (Apriliyanti et al., 2021). The study hypothesises a positive effect of digital skills on both outcomes (H1c).

This hypothesis is grounded in the broader argument that second-level digital divide effects on participation quality may rival or exceed first-level access effects in contexts where basic internet penetration has reached moderate levels (Robinson et al., 2015).

Affordability—the perceived financial burden of internet access and data costs—operates as an ongoing participation barrier that persists even among those with physical access. The study hypothesises a negative effect of affordability constraints on both outcomes (H1b).

2.3 Cybersecurity Risk Perceptions

Privacy risk—the perceived likelihood that personal data or opinions disclosed on government digital platforms will be misused, shared without consent, or used for purposes beyond the stated intent—has been shown to erode trust in digital systems and suppress users' willingness to disclose information (McKnight et al., 2017; Bélanger & Crossler, 2011). In the e-participation context, where citizen input requires both personal identification and opinion disclosure, privacy risk perceptions constitute a structurally distinct barrier to engagement. In the Malaysian e-participation context, where the Personal Data Protection Act 2010 does not fully extend to government data processing, privacy risk perceptions may be particularly elevated. The study hypothesises that higher privacy risk perceptions negatively predict both outcomes (H2a).

Security risk—concerns about account compromise, data breaches, or unauthorised access to government digital platform accounts—operates as a distinct facet of cybersecurity threat appraisal. In Malaysia, where high-profile government data breach incidents have periodically eroded public confidence in the security of state digital systems, security risk perceptions may translate directly into reluctance to register accounts or submit participation inputs through government digital channels. The study hypothesises a negative effect of security risk perceptions on both outcomes (H2b).

Misinformation risk represents an emerging third facet of cybersecurity risk that has received limited attention in e-participation scholarship despite its growing salience in the post-deepfake era (Chesney & Citron, 2019). The study hypothesises a negative effect of misinformation risk on both outcomes (H2c).

The inclusion of misinformation risk as a distinct third cybersecurity facet represents a theoretical contribution of this study: existing e-government adoption research has predominantly operationalised cybersecurity risk through privacy and security dimensions, leaving the information integrity dimension largely unmeasured.

Treating misinformation risk within the cybersecurity family warrants explicit justification, since misinformation also belongs to debates on information integrity, media trust, and platform governance. The rationale here is twofold. Conceptually, contemporary security frameworks define the protection goals of information systems as confidentiality, integrity, and availability; coordinated manipulation, inauthentic engagement, and AI-generated false content threaten the integrity of the civic information environment in which government platforms operate—on such platforms, the asset at risk is the trustworthiness of the communication channel itself (Chesney & Citron, 2019). Empirically, the three risk perceptions in this study are discriminant yet correlated and operate on the outcomes in the same direction (Section 4), supporting their treatment as one cybersecurity-related family with distinct components. The label "cybersecurity-related risk perceptions" is used in this sense throughout.

2.4 Trust as Risk Moderator (H3) and Direct Predictor

Trust in government digital participation contexts operates across multiple distinct but interrelated dimensions (Abdulkareem & Mohd Ramli, 2022; Alzahrani et al., 2017). Institutional trust—confidence that government agencies are competent, transparent, and responsible stewards of citizen data and inputs—may reduce the behavioural consequences of perceived privacy, security, and misinformation risks. Technology trust—confidence that the platform infrastructure is reliable, secure, and functional—may buffer users against interpreting perceived cybersecurity threats as reasons for disengagement. Procedural trust—belief that the participation process is fair, that citizen inputs are genuinely considered, and that voice translates into policy influence—may make risk-bearing participation appear more worthwhile than performative (Lindner & Aichholzer, 2019). The study therefore tests whether the three trust dimensions moderate the effects of the three cybersecurity-related risk perceptions on both outcomes (H3), while also examining their independent direct predictive effects as an exploratory complement to the moderation analysis.

Beyond access, skills, and trust, citizens' sense of political efficacy—the belief that ordinary people can influence public decisions and that input expressed through appropriate channels will be heard—is a recognised proximal driver of e-participation (Lai & Beh, 2025). Procedural trust is the closest construct in the present model, but the two are distinct: procedural trust concerns whether a specific feedback process is fair and responsive, whereas political efficacy concerns citizens' generalised beliefs about their own influence. Low procedural trust and low external efficacy are nonetheless empirically adjacent—citizens who doubt that submissions are processed fairly may also doubt that participation can matter at all—so efficacy-based explanations of the participation deficit remain open in this design and are returned to in the limitations (Section 6).

2.5 Configurational Approach (RQ4): Necessary and Sufficient Conditions

Variable-oriented analyses model the net, symmetric effects of individual predictors but cannot reveal which combinations of conditions are jointly sufficient for an outcome, whether equifinal pathways exist to the same outcome through different combinations, or whether the absence of a condition is as analytically consequential as its presence. Fuzzy-set Qualitative Comparative Analysis (fsQCA) addresses these limitations through set-theoretic logic: it identifies necessary conditions—whose absence consistently prevents the outcome regardless of other conditions—and sufficient configurations—whose presence is consistently associated with the outcome through conjunctions of multiple conditions under set-theoretic criteria (Ragin, 2008). The configurational approach is particularly appropriate for e-participation research for two reasons. First, participation is plausibly produced by multiple, non-additive combinations of enabling conditions—physical access alone is insufficient without skills, and skills alone may be insufficient without trust or low perceived risk.

Second, the asymmetric logic of fsQCA allows the analysis of non-participation as a distinct outcome with its own configurational structure, rather than simply the absence of a participation-enabling configuration. This matters for policy: the conditions associated with high participation are not necessarily the mirror image of those associated with non-participation. Despite these advantages, configurational approaches remain relatively uncommon in e-participation research. Dual PLS-SEM/fsQCA designs have, however, begun to appear in e-government participation research, including in Southeast Asia (Hutahaean et al., 2023). This study contributes to closing that gap by applying fsQCA to the participatory governance domain and demonstrating its utility for identifying the compound barrier structures that sustain non-participation.

3. Research Design and Methods

3.1 Sample and Data Collection

The target population comprised Malaysian adults aged 18 and above who had used any government online channel for information retrieval, service transactions, or participatory engagement within the preceding twelve months. A non-probability stratified quota sampling design was used to improve coverage across Malaysian urban (43.7%), suburban (36.3%), and rural (20.1%) localities, and income representation across B40 (34.2%), M40 (41.9%), and T20 (15.9%) household income bands; the income item was optional, and the remaining 8.0% of respondents selected "prefer not to say". Mixed-mode administration yielded 440 completed questionnaires.

Five-stage data cleaning was applied: (1) eligibility verification; (2) government channel use screening (removing 88 non-users); (3) attention check removal (removing 13); (4) straight-line response screening (no cases); (5) missing data review (no cases exceeded 10%). The final usable sample comprised n = 339 respondents (retention rate 77.0%), statistically adequate for nine predictors at medium effect size ($f^2 = 0.15$, $\alpha = .05$; Cohen, 1988). The sample was near-balanced by gender (46.6% male, 49.6% female, 2.1% non-binary, 1.8% prefer not to say), skewed younger (59.3% aged 18–34), and predominantly educated (41.9% bachelor's degree holders). Data were collected between November 2023 and January 2024. Mixed-mode administration combined online distribution via government digital platform community channels and offline intercept administration at public service centres, ensuring inclusion of both digitally active and less digitally engaged respondents within the eligibility criteria. Ethical approval was obtained from the relevant institutional review board; participation was voluntary and all responses were anonymised prior to analysis. The younger-skewed and education-skewed profile is consistent with the characteristics of the accessible Malaysian e-participation user population and limits generalisation to older and lower-education segments. Because the eligibility screen required prior use of a government online channel, the sample represents users of Malaysian government digital platforms rather than the Malaysian adult population; respondents facing first-level exclusion lie outside the sampling frame, so a digitally advantaged sample of this kind will, if anything, understate access and skills barriers in the population at large. All findings and claims in this article should be read with this scope in mind.

3.2 Measures

All constructs used seven-point Likert scales adapted from validated instruments. Physical access and digital skills items were adapted from Van Dijk (2020) and Mossberger et al. (2013). Affordability items were adapted from Robinson et al. (2015). Privacy risk and security risk items were adapted from McKnight et al. (2017). Misinformation risk items were developed drawing on Chesney and Citron (2019) and Cinelli et al. (2021). Institutional trust items were adapted from Abdulkareem and Ramli (2022); technology trust items from Alzahrani et al. (2017); and procedural trust items from Lindner and Aichholzer (2019). E-participation behaviour items were developed following Macintosh and Whyte (2008); perceived platform effectiveness items were adapted from Davis (1989). All adapted items were reviewed by two subject-matter experts with e-government and digital participation expertise and pre-tested in a pilot of 35 Malaysian government digital platform users prior to main data collection. Pilot respondents were asked to rate item clarity and relevance on a separate scale in addition to completing the instrument. Minor wording adjustments were made to the misinformation risk items and the procedural trust items to reflect the Malaysian administrative context, specifically replacing generic government references with references to Malaysian government digital platforms; no items were dropped at this stage. The analytical model comprised 41 reflective items across eleven constructs. Additional auxiliary, control, marker, and quality-check items were included in the questionnaire but were not part of the main structural model. Attitudinal items were administered on a seven-point Likert scale anchored at 1 (strongly disagree) to 7 (strongly agree); the four e-participation behaviour items used a frequency format referring to the preceding twelve months, anchored at 1 (never) to 7 (extremely often), capturing expressive and consultative acts (feedback, complaints, consultations and polls, interaction with official accounts on public issues) rather than informational or transactional platform use. Full item wording, response anchors, and construct assignments are provided in Appendix A; no items were deleted during measurement validation.

3.3 Analytical Approach

The study employs a two-stage analytical design. In Stage 1, PLS-SEM was conducted in SmartPLS 4 (Hair et al., 2022) using the path weighting scheme with standardised results. Bootstrap significance testing employed 5,000 sub-samples with a two-tailed test at $\alpha = .05$ (Henseler et al., 2015). Moderation was tested using the Two-Stage approach (Henseler & Chin, 2010): latent variable scores from Stage 1 PLS-SEM were extracted and used as inputs to Stage 2 OLS regression with product-indicator interaction terms, implemented in Python 3.11 (statsmodels v0.14). Eighteen interaction terms were tested, formed by crossing the three trust dimensions with the three cybersecurity-related risk perceptions and estimating the nine trust × risk products separately for each of the two outcomes. HC3 heteroscedasticity-consistent standard errors were applied as a robustness check; results were substantively identical to standard OLS, confirming that the limited moderation pattern is not an artefact of error structure. Cross-validated predictive relevance (CV-R^2) was estimated via 10-fold cross-validation in PLSpredict. Because the data are cross-sectional and observational, PLS-SEM path coefficients are interpreted as standardised conditional associations within the specified model, not as estimates of causal effects.

In Stage 2, fsQCA (Ragin, 2008) was conducted on the construct mean scores of the eleven model variables, calibrated to fuzzy-set membership (0–1) with the direct method, which maps the anchors for full membership, the crossover point, and full non-membership onto log-odds of +3, 0, and −3. For the five enabling conditions (PA, DS, IT, TT, PTR), anchors were: fully in = 6.0, crossover = 4.0, fully out = 2.0. The three cybersecurity risk conditions were inverted (fully in = 2.0, crossover = 4.0, fully out = 6.0), so that high membership denotes low perceived risk (PR_low, SR_low, MR_low); the affordability condition (AFF) used the same 6.0/4.0/2.0 anchors, with its negation (~AFF) denoting the absence of cost constraints.

Because e-participation is strongly floor-clustered and right-skewed (M = 2.91, Mdn = 3.00, skewness = +0.47), calibrating the outcome at the scale midpoint would assign almost nine in ten respondents to non-membership and leave the outcome set too sparse for sufficiency analysis. The outcome was therefore calibrated with full membership at 5.0 (consistently frequent participation on the never–extremely often scale), full non-membership at 1.0 (the scale floor, "never"), and the crossover at the sample mean of 2.91. Set membership thus denotes above-average participation within this sample of platform users—an explicitly sample-relative definition whose consequences are examined in a calibration sensitivity analysis (Section 4.4). Perceived platform effectiveness was calibrated at the theoretical anchors 6.0/4.0/2.0. Construct means falling exactly on a crossover yield memberships of exactly 0.50; such cases were treated as non-members for truth-table assignment (strict > 0.50 rule).

Necessity was assessed against the conventional benchmark (consistency ≥ 0.90), reported together with necessity coverage. For sufficiency, the truth table (2^9 = 512 rows) retained rows with at least two best-fit cases; rows were coded sufficient when raw consistency ≥ 0.80 and PRI consistency ≥ 0.50, the latter guarding against simultaneous subset relations that arise with large outcome sets (Schneider & Wagemann, 2012; Greckhamer et al., 2018). Quine–McCluskey minimisation produced conservative, parsimonious, and intermediate solutions. Directional expectations for the intermediate solution were that access, skills, the three trust dimensions, and the three low-risk conditions contribute to participation by their presence, and affordability constraints by their absence. The intermediate solution is reported as primary, with core conditions identified as those also contained in the parsimonious solution (Fiss, 2011). The calibration and minimisation code is available from the authors on request.

4. Results

4.1 Measurement Model Assessment

All eleven constructs demonstrated satisfactory reliability and validity. Cronbach's alpha ranged from 0.755 (Privacy Risk) to 0.947 (E-Participation), and composite reliability (ρ_c) ranged from 0.841 to 0.962, with all values exceeding the conventional 0.70 threshold (Hair et al., 2022). The rho_A values, which are less susceptible to upward bias than ρ_c in PLS-SEM (Dijkstra & Henseler, 2015), also fell within acceptable ranges across all constructs (0.745–0.948). Average Variance Extracted (AVE) exceeded 0.50 for all constructs (range: 0.521–0.862), confirming that constructs explain more variance in their indicators than does measurement error, satisfying the convergent validity criterion. Outer loadings ranged from 0.551 (IT3) to 0.935 (COM1), with only two items (IT1 = 0.622, IT3 = 0.551) falling below the preferred 0.70 threshold; these were retained given satisfactory AVE and because removal did not substantively improve reliability estimates. Discriminant validity was established via Heterotrait-Monotrait (HTMT) ratios, all below the conservative 0.85 threshold (max HTMT = 0.348, PA↔EP), indicating that no two constructs are empirically indistinguishable (Henseler et al., 2015). The Fornell-Larcker criterion was also satisfied. Common method bias was assessed via Harman's single-factor test (Podsakoff et al., 2003) (single factor accounted for 11.2% of total variance) and a marker-variable analysis (mean correlations below $r = 0.08$ after partialling out the marker). Neither diagnostic indicated substantial common method variance; however, because the main constructs were self-reported within a single survey instrument, these diagnostics cannot rule out common method bias entirely. As a further check on the conceptual boundary of the participation construct, a three-item transactional usage-intensity measure included in the instrument ($\alpha = .77$; $M = 4.02$) was essentially uncorrelated with e-participation behaviour ($r = -.02$): respondents use the platforms transactionally far more than they participate, and the two behaviours do not covary, confirming that the dependent variable captures participatory rather than general platform use.

4.2 Structural Associations: RQ1 and RQ2

Figure 1 presents the full structural model with standardised path coefficients, and Table 1 provides exact coefficients, confidence intervals, p-values, and effect sizes for all structural paths. For e-participation, physical access showed the largest positive standardised association ($\beta = 0.276$, $p < .001$, $f^2 = 0.101$). Technology trust ($\beta = 0.188$, $p < .001$) and institutional trust ($\beta = 0.156$, $p = .032$) were also positively associated with e-participation. All three cybersecurity risk perceptions were significantly negatively associated with e-participation: privacy risk most strongly ($\beta = -0.185$, $p < .001$), followed by misinformation risk ($\beta = -0.135$, $p = .006$) and security risk ($\beta = -0.113$, $p = .021$). The model explained 25.5% of variance in e-participation ($R^2 = 0.255$, CV-$R^2 = 0.213$).

For perceived platform effectiveness, affordability showed a significant negative association ($\beta = -0.118$, $p = .020$), while none of the trust dimensions showed significant associations. Misinformation risk showed the largest negative standardised association ($\beta = -0.200$, $p < .001$, $f^2 = 0.054$), followed by security risk ($\beta = -0.165$) and privacy risk ($\beta = -0.155$). The model explained 27.0% of variance in PPE ($R^2 = 0.270$, CV-$R^2 = 0.208$).

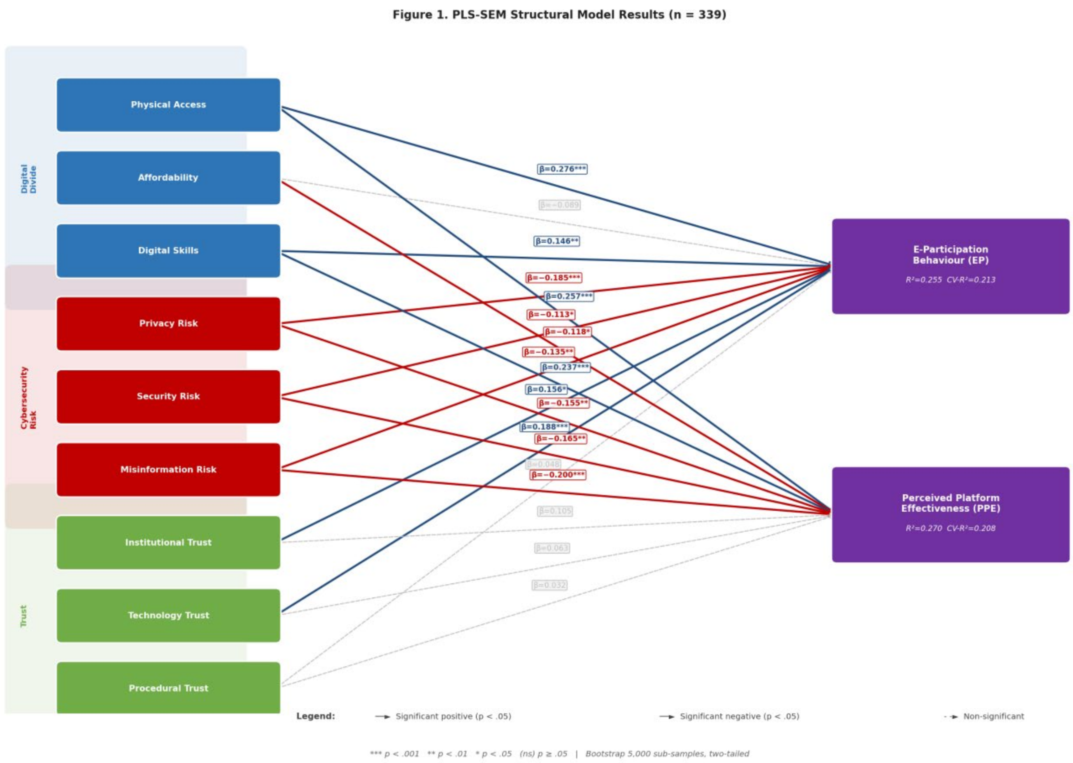

Figure 1. PLS-SEM Structural Model Results (n = 339). Standardised path coefficients from SmartPLS 4 bootstrapping (5,000 sub-samples, two-tailed). Solid lines = significant ($p < .05$); dashed = non-significant.

Table 1: PLS-SEM Structural Path Estimates — Bootstrapping Results (n = 339, 5,000 sub-samples)

Panel A. E-participation (R^2 = 0.255; CV-R^2 = 0.213)

Predictor	β	95% CI	p	f^2
Physical Access (H1a)	0.276	[0.184, 0.369]	< .001	0.101
Affordability (H1b)	−0.089	[−0.191, 0.013]	.119	0.011
Digital Skills (H1c)	0.146	[0.054, 0.238]	.002	0.028
Privacy Risk (H2a)	−0.185	[−0.279, −0.092]	< .001	0.045
Security Risk (H2b)	−0.113	[−0.203, −0.023]	.021	0.017
Misinformation Risk (H2c)	−0.135	[−0.233, −0.038]	.006	0.024
Institutional Trust	0.156	[0.055, 0.257]	.032	0.032
Technology Trust	0.188	[0.086, 0.289]	< .001	0.047
Procedural Trust	0.048	[−0.044, 0.140]	.374	0.003

Panel B. Perceived platform effectiveness (R^2 = 0.270; CV-R^2 = 0.208)

Predictor	β	95% CI	p	f^2
Physical Access (H1a)	0.257	[0.161, 0.353]	< .001	0.089

Affordability (H1b)	−0.118	[−0.213, −0.023]	.020	0.019
Digital Skills (H1c)	0.237	[0.152, 0.321]	< .001	0.076
Privacy Risk (H2a)	−0.155	[−0.254, −0.055]	.002	0.032
Security Risk (H2b)	−0.165	[−0.259, −0.072]	.001	0.037
Misinformation Risk (H2c)	−0.200	[−0.292, −0.109]	< .001	0.054
Institutional Trust	0.105	[−0.022, 0.232]	.106	0.015
Technology Trust	0.063	[−0.037, 0.163]	.215	0.005
Procedural Trust	0.032	[−0.061, 0.126]	.717	0.001

Note. β = standardised path coefficient; CI = 95% confidence interval; f^2 = incremental effect size. Small effect size ≥ 0.02; medium ≥ 0.15 (Cohen, 1988).

4.3 Moderation Effects: RQ3

Eighteen interaction terms were tested via two-stage OLS moderation; the full coefficient tables—β, standard errors, 95% confidence intervals, conventional and HC3-robust p-values, and f^2 effect sizes for all eighteen terms—are provided in Appendix B. Two interaction terms nominally crossed the uncorrected $\alpha = .05$ threshold—Institutional Trust × Misinformation Risk → EP ($\beta = 0.113$, $p = .030$, robust $p = .053$) and Technology Trust × Privacy Risk → PPE ($\beta = 0.116$, $p = .015$)—but neither survived Bonferroni correction ($\alpha\_corrected = .003$), and all eighteen interaction effect sizes were below the conventional threshold for even a small effect (all $f^2 \leq 0.018$). These results constitute limited evidence of moderation under the tested specification and correction method; they should not be read as demonstrating that trust cannot function as a moderator. Within this design, trust is more consistently observed as a positive direct correlate of e-participation than as a demonstrable conditional boundary condition. Several factors may explain the limited evidence of moderation. First, in a context where procedural trust is generally low ($M = 3.53$) and physical access varies substantially, the statistical power available to detect small interaction effects is limited even at $n = 339$, particularly after Bonferroni correction. Second, the two-stage OLS approach, while appropriate for PLS-SEM interaction testing, centres interaction terms on latent variable scores that are already partially correlated, which can attenuate interaction coefficients. Third, it is theoretically plausible that trust and risk perceptions operate through parallel pathways to participation rather than through multiplicative moderation: both influence participation directly and independently, without one amplifying or dampening the other. Appendix B provides full interaction coefficients, standard errors, and confidence intervals for all 18 paths, allowing readers to assess the magnitude of null effects and evaluate whether the Bonferroni correction may have been conservative given the exploratory nature of moderation testing in this domain.

4.4 Configurational Analysis: RQ4

Necessary-condition analysis identified physical access (PA) as the only condition exceeding the conventional benchmark (consistency ≥ 0.90; Ragin, 2008) for both outcomes: consistency = 0.958 with necessity coverage = 0.578 for high e-participation, and consistency = 0.940 with coverage = 0.722 for high perceived platform effectiveness. Digital skills approached the benchmark for both outcomes (0.875 and 0.863); no trust dimension and no individual risk condition was necessary on its own. Because Boolean minimisation can remove a necessary condition from sufficient solution terms when it is present in (almost) all empirical configurations, necessity and sufficiency are assessed and reported separately throughout (Ragin, 2008; Schneider & Wagemann, 2012).

Fifteen of the 56 observed truth-table rows met the sufficiency benchmarks for high e-participation. The intermediate solution comprises nine equifinal configurations (Table 2; solution consistency = 0.810, PRI = 0.566, coverage = 0.686). Three features stand out. First, physical access appears in every configuration and digital skills in eight of the nine, echoing the necessity analysis: access and skills form the common base of participation routes. Second, physical access is peripheral in all nine routes, while digital skills is mostly peripheral, appearing as a core condition only in EP1 and appearing in its absence in the niche EP9 path. The other differentiating cores are combinations of low risk perception, affordability, and trust (for example PR_low ·SR_low, PR_low ·TT, IT ·PR_low, and ~AFF ·PTR ·TT). Third, the absence of affordability constraints (~AFF) is part of six of the nine routes. Substantively, among users who clear the near-universal access-and-skills baseline, what separates participants from non-participants is the trust–risk–affordability calculus. A case-level audit of the skills-led pattern reported in the original analysis confirms this reading: participants fitting that pattern almost universally also hold physical access (17 of 18 cases; mean raw access score 5.19 of 7); skills complement, but do not substitute for, access.

For perceived platform effectiveness, every observed truth-table row met the sufficiency benchmarks under the theoretical calibration (56 of 56), reflecting the uniformly favourable effectiveness judgements in this sample (M = 4.45); a sufficiency solution would therefore be tautological and is not reported. Configurational claims for platform effectiveness are accordingly confined to the necessity result above, and its drivers are interpreted through the structural model.

Low-participation configurations exhibit an asymmetric pattern (Table 3; solution consistency = 0.793, PRI = 0.602, coverage = 0.750). In the parsimonious solution, the absence of physical access alone is quasi-sufficient for low participation (consistency = 0.899, PRI = 0.723), and the intermediate routes combine elevated risk perceptions with absent trust—frequently together with affordability constraints and skill deficits (e.g., LP7–LP8). In these compound configurations, even citizens with adequate physical access remain non-participating because risk perceptions, distrust, costs, and skill deficits operate conjuncturally rather than in isolation.

Table 2: fsQCA Intermediate-Solution Configurations for High (Above-Average) E-Participation (n = 339)

ID	Configuration	Cons.	PRI	Raw cov.	Unique cov.	n
EP1	**~AFF** ·**DS** ·**IT** ·PA ·**TT**	0.839	0.542	0.463	0.034	27
EP2	**~AFF** ·DS ·PA ·**PTR** ·**TT**	0.856	0.549	0.404	0.014	16
EP3	DS ·PA ·**PR_low** ·**TT**	0.897	0.657	0.401	0.021	17
EP4	**~AFF** ·DS ·**~IT** ·PA ·**SR_low** ·**TT**	0.887	0.583	0.374	0.012	11
EP5	DS ·PA ·**PR_low** ·**SR_low**	0.914	0.682	0.357	0.008	9
EP6	~AFF ·DS ·**IT** ·PA ·**PR_low**	0.889	0.577	0.344	0.013	9

EP7	**AFF** ·DS ·**IT** ·PA ·**SR_low** ·TT	0.886	0.533	0.313	0.015	6
EP8	~AFF ·DS ·**MR_low** ·PA ·**SR_low**	0.903	0.630	0.306	0.014	3
EP9	~AFF ·**~DS** ·**MR_low** ·PA ·TT	0.916	0.545	0.236	0.009	2

Note. Intermediate solution. Conditions in bold are core (also contained in the parsimonious solution); others are peripheral. ~ denotes set negation; PR_low, SR_low and MR_low denote low perceived privacy, security and misinformation risk, so ~AFF denotes the absence of affordability constraints. Cons. = raw consistency; PRI = proportional reduction in inconsistency; n = cases with configuration membership > 0.5 (best fit). Benchmarks: frequency ≥ 2, raw consistency ≥ 0.80, PRI ≥ 0.50. Overall solution: consistency = 0.810, PRI = 0.566, coverage = 0.686.

Table 3 presents the intermediate-solution configurations for low e-participation.

Table 3: fsQCA Intermediate-Solution Configurations for Low E-Participation (n = 339)

ID	Configuration	Cons.	PRI	Raw cov.	Unique cov.	n
LP1	**~MR_low** ·**~PR_low** ·**~TT**	0.818	0.611	0.617	0.100	87
LP2	**~IT** ·~MR_low ·~PTR ·**~SR_low** ·**~TT**	0.901	0.696	0.439	0.017	23
LP3	**~IT** ·~PR_low ·~PTR ·**~SR_low** ·**~TT**	0.905	0.700	0.428	0.006	19
LP4	**AFF** ·~MR_low ·**~PR_low** ·~PTR ·**~SR_low**	0.875	0.662	0.424	0.009	24
LP5	**AFF** ·**~IT** ·~MR_low ·**~PR_low** ·~PTR	0.875	0.650	0.416	0.012	24
LP6	**AFF** ·**~IT** ·~MR_low ·**~PR_low** ·**~SR_low**	0.888	0.684	0.399	0.005	22
LP7	**~DS** ·**~MR_low** ·~PR_low ·~PTR ·**~SR_low**	0.897	0.697	0.397	0.018	17
LP8	**AFF** ·**~DS** ·**~MR_low** ·**~PR_low** ·**~SR_low**	0.897	0.661	0.315	0.002	8
LP9	~IT ·~MR_low ·**~PA** ·~PR_low ·~PTR ·~SR_low	0.948	0.787	0.261	0.002	0

Note. Intermediate solution for the negation of the participation set; notation and benchmarks as in Table 2. ~PR_low, ~SR_low and ~MR_low denote elevated risk perception; AFF denotes the presence of affordability constraints. LP9 has no best-fit cases (n = 0); it is retained as part of the minimised solution and contributes negligible unique coverage. In the parsimonious solution, the absence of physical access alone is quasi-sufficient for low participation (consistency = 0.899, PRI = 0.723). Overall solution: consistency = 0.793, PRI = 0.602, coverage = 0.750.

Calibration sensitivity. Recalibrating the participation outcome at the theoretical midpoint (anchors 6.0/4.0/2.0) shrinks the high-participation set to 41 cases (12.1%), confirming that high participation in an absolute sense is rare in this population. The necessity of physical access strengthens (consistency = 0.986), though its coverage falls to 0.293—a near-universal condition for a rare outcome—and digital skills also crosses the benchmark (0.939), indicating that the uniqueness of access as a necessary condition is itself calibration-dependent. No truth-table row satisfies the sufficiency benchmarks under this calibration (0 of 56): in absolute terms, high participation is not only rare but lacks any consistently sufficient recipe in these data. Sufficiency findings should therefore be read as identifying routes to above-average participation within this user population, not to high participation in an absolute sense.

4.5 Robustness to Demographic Controls

As a robustness check, the structural relations were re-estimated with sixteen demographic dummy variables (gender, age band, education, residential area, and income bracket including "prefer not to say") added to latent-variable score OLS regressions (Appendix C). These OLS models are not used as the primary inferential basis, which remains the SmartPLS bootstrap results in Table 1; rather, they assess whether the direction and substantive magnitude of the main relationships are sensitive to demographic composition. The signs of all eighteen main coefficients remain unchanged, and coefficient magnitudes are stable (maximum $|\Delta\beta| = 0.035$). Among the controls, rural residence is negatively associated with perceived platform effectiveness, and T20 income is positively associated with both outcomes—patterns consistent with the digital-divide framing and returned to in Section 5.

5. Discussion

5.1 Structural Digital Inequality

The finding that physical access shows the largest positive standardised association with e-participation ($\beta = 0.276$, $f^2 = 0.101$) and the only necessary condition within the present set-theoretic specification (consistency = 0.958, coverage = 0.578) suggests that infrastructure access functions as a foundational necessary condition (in the set-theoretic sense) for digital participation among the platform users examined here. This convergence between variable-oriented and set-theoretic analyses strengthens confidence in the robustness of the association, though it is appropriately bounded by the conditions and outcome space included in this study. Within this configurational space and calibration, the absence of physical access is associated with consistently low participation regardless of what other enabling conditions are present—an asymmetric relationship that variable-oriented analysis cannot detect. This provides set-theoretic evidence consistent with Van Dijk's (2020) first-level divide argument. The re-estimated sufficiency analysis reinforces the point from the opposite direction: physical access appears in every one of the nine sufficient configurations, and digital skills in eight, yet access is never a core condition—a near-universal baseline cannot differentiate among participation routes, which is precisely the signature of a necessary background condition (Fiss, 2011).

The implication for Malaysian digital governance is that skills-focused and trust-building interventions may be less effective where physical connectivity remains inadequate. Malaysia's National Digital Infrastructure Plan and Jalinan Digital Negara (JENDELA) broadband expansion programme are therefore not simply desirable complements to e-participation initiatives; their presence may condition whether other participation-enabling policies can take effect. This is a cautious policy emphasis derived from the configurational necessity finding within the present study's analytical scope, and one that applies to the sampled population of platform users rather than to the Malaysian population at large.

From a participatory governance perspective, unequal access to government digital platforms may function as a form of structural exclusion from democratic participation channels, not merely a technical inconvenience. This framing aligns with the United Nations' positioning of digital access as foundational to the realisation of civic rights in digital governance environments (United Nations, 2022). The significant positive association of digital skills with both outcomes (EP: $\beta = 0.146$, $p = .002$; PPE: $\beta = 0.237$, $p < .001$) further elaborates the structural enablement logic. The stronger effect of digital skills on perceived platform effectiveness than on e-participation behaviour suggests that competent navigation of government digital platforms translates most immediately into more positive platform evaluations, while behavioural engagement may additionally require motivational and trust conditions not captured by skills alone. This is consistent with the second-level divide literature's argument that skill gaps produce not only non-participation but also lower-quality engagement and less favourable evaluations of digital institutions among those who do engage (Van Dijk, 2020; Robinson et al., 2015). Affordability, by contrast, showed a non-significant association with e-participation ($\beta = -0.089$, $p = .119$), though a nominally significant negative association with platform effectiveness ($\beta = -0.118$, $p = .020$). This asymmetry suggests that affordability barriers may be more salient as evaluative constraints—shaping whether citizens perceive a platform as worth the costs of access—than as immediate behavioural gatekeepers in this sample, possibly because the quota sampling design over-represents those with at least intermittent connectivity. In the re-estimated fsQCA, the absence of affordability constraints (~AFF) is part of six of the nine sufficient configurations for above-average participation, indicating that affordability's role becomes visible in configurational rather than additive logic; consistently, the robustness model shows T20 income positively associated with both outcomes and rural residence negatively associated with perceived platform effectiveness (Appendix C).

5.2 Information Integrity and the Trust-Risk Calculus

The consistent and significant negative associations of all three cybersecurity-related risk facets with both outcomes support treating these perceptions as independent participation barriers that cannot be reduced to general trust deficits or access inequalities. This finding extends cybersecurity risk perception theory (McKnight et al., 2017) into the participatory governance domain.

Misinformation risk showed the largest negative standardised association with platform effectiveness evaluations in this dataset and operationalisation ($\beta = -0.200$, $f^2 = 0.054$), suggesting that perceived information environment integrity is central to platform legitimacy. Government digital platforms are evaluated as part of the broader digital information ecosystem. Where that ecosystem is perceived as corrupted by deepfakes or disinformation, platform legitimacy may suffer even when the platform's own technical security is adequate. This is consistent with Vosoughi et al.'s (2018) evidence on false news spread.

For Malaysian e-governance, this points to an ecosystem-level governance challenge. Whole-of-government strategies aimed at signalling information integrity—verified government account certification, cross-platform content standards, transparent correction protocols—may yield disproportionate returns for platform effectiveness perceptions. The finding that all three risk facets show independent negative associations with participation, rather than being reducible to a single generalised risk construct, has important measurement implications. Studies that collapse privacy, security, and misinformation risk into a single cybersecurity measure may systematically underestimate the heterogeneous pathways through which risk perceptions are associated with lower participation, and may fail to identify misinformation's distinctive role in shaping how citizens evaluate the information environment in which government platforms are embedded. Future e-participation research should treat these as conceptually and empirically distinct constructs.

A further finding concerns the role of trust. Within this design, trust is more consistently observed as a positive direct correlate of e-participation than as a demonstrable conditional moderator: none of the eighteen trust × risk interaction terms survived correction for multiple testing, and all interaction effect sizes were trivial (Appendix B). Given the limited power to detect small interactions under family-wise correction at $n = 339$, this constitutes limited evidence of moderation under the tested specification rather than evidence against trust moderation in general; with that caveat, the pattern sits more comfortably with framings of trust as a co-occurring enabler than as a boundary condition (Lindner & Aichholzer, 2020; Norris, 2011).

The contrast between institutional trust (significant positive association, $p = .032$) and procedural trust (non-significant, lowest mean $M = 3.53$) is particularly informative. Users in this sample may be willing to engage with government platforms on the basis of general institutional confidence while simultaneously doubting whether their input will be meaningfully incorporated—a politically significant dissociation pointing to the credibility gap in Malaysia's current e-consultation arrangements. In the vocabulary of participation theory, channels of this kind risk delivering symbolic rather than meaningful participation: input is collected, but citizens do not perceive that it is processed or visibly answered—an efficacy-adjacent deficit (Lai & Beh, 2025) that the procedural-trust measure captures only in part.

Reading trust as a positive correlate rather than a demonstrated moderator—within the evidential bounds just noted—suggests that efforts to strengthen baseline trust through demonstrated institutional accountability, technical security investment, and visible information integrity may be a more tractable policy direction than designing trust-contingent interventions.

The contrast between the positive association of institutional trust with participation and the null association of procedural trust resonates with Beetham's (1991) distinction between legitimacy based on legal authority and legitimacy based on justifiable normative standards. The practical implication is that procedural trust improvements may be necessary to sustain participation quality in the long run, even if they are not the immediate trigger for initial engagement.

This dispositional framing is consistent with civic voluntarism research identifying attitudinal orientations toward political institutions as stable individual-level predictors of participation that operate alongside contextual barriers (Verba et al., 1995). The finding that technology trust is significantly positively associated with e-participation ($p < .001$) but not with perceived platform effectiveness warrants further examination. One interpretation is that technology trust may be more closely associated with the decision to engage behaviourally—including lower hesitation at the point of login or data entry—than with evaluative judgments of platform quality, which may be driven more by information environment perceptions captured by misinformation risk. For Malaysian e-governance, the practical implication is that technology trust interventions—such as visible security certifications, multi-factor authentication options, and transparent data handling statements—may be particularly relevant to behavioural participation, while perceived platform effectiveness evaluations may require ecosystem-level governance strategies that address the broader information integrity environment.

5.3 Plural Pathways and the Participation Deficit

The re-estimated fsQCA contributes three insights unavailable from the PLS-SEM results. First, there is no single road into e-participation: nine equifinal configurations are associated with above-average participation within this user sample (Table 2). All nine rest on the access-and-skills base, and what differentiates them are core combinations of low perceived risk and trust—privacy reassurance paired with technology or institutional trust in some routes, security reassurance paired with technology or procedural trust in others. Different citizen segments thus reach participation through distinct trust–risk profiles, implying targeted rather than one-size-fits-all policy design.

Second, the calibration sensitivity analysis disciplines the meaning of these routes. Under the theoretical midpoint calibration, only 12.1% of respondents qualify as high participators and no configuration is consistently sufficient: in absolute terms, high participation in this population is rare and lacks any reliable recipe. The nine configurations therefore describe routes to above-average—not absolutely high—participation, and the participation deficit itself remains the headline empirical fact.

Third, the low-participation analysis (Table 3) shows the compound structure of that deficit. The absence of physical access alone is quasi-sufficient for low participation, and the remaining routes combine elevated risk perceptions with absent trust—frequently together with affordability constraints and skill deficits. This conjunctural logic implies that single-factor interventions are unlikely to dissolve non-participation; coordinated interventions addressing connectivity, costs, skills, and the perceived integrity and safety of the information environment are required. Whether efficacy beliefs constitute an additional, unmeasured component of these compound barriers is an open question for future designs (Lai & Beh, 2025).

These configurational findings also illustrate the value of methodological complementarity. PLS-SEM shows that procedural trust has no significant average association; fsQCA shows procedural trust as a core ingredient of one sufficient route (EP2)—an asymmetric, context-dependent role invisible to net-effects analysis. The same holds for affordability, whose small average association with participation ($\beta = -0.089$, n.s.) coexists with the presence of ~AFF in six of nine sufficient configurations. For digital-inclusion policy in Malaysia, the findings collectively support an emphasis on connectivity and affordability as base conditions, combined with targeted digital skills programmes for distinct citizen segments, evidence-based risk communication that distinguishes legitimate risks from correctable misperceptions, and ecosystem-level governance of information integrity—particularly misinformation—that shapes how citizens perceive the legitimacy and safety of government digital participation channels.

6. Conclusion

This study contributes to the participatory governance and e-participation literature through a dual-method analysis integrating PLS-SEM and fsQCA to examine the structural, perceptual, and institutional correlates of Malaysian government e-participation. Four substantive contributions emerge.

First, physical access appears to function as a necessary condition (in the set-theoretic sense, within this sample and calibration) for both high e-participation and high platform effectiveness, providing configurational evidence consistent with digital divide theory and suggesting cautious implications for policy prioritisation.

Second, all three cybersecurity-related risk perception facets show independent significant negative associations with both outcomes, with misinformation risk showing the largest negative association with platform effectiveness evaluations in this dataset and operationalisation. This supports treating misinformation risk as a governance challenge operating at the information ecosystem level.

Third, trust is more consistently observed as a positive direct correlate of e-participation, with no moderation effect surviving correction for multiple testing in this design—a pattern that, within the power limits of the tested specification, favours treating trust as a co-occurring enabler rather than as a boundary condition.

Fourth, the fsQCA analysis reveals nine equifinal configurations for above-average e-participation within this user sample, all resting on an access-and-skills base and differentiated by core combinations of trust and low perceived risk, while compound combinations of elevated risk perceptions, absent trust, affordability constraints, and skill deficits characterise low-participation configurations.

The study has several limitations that bound the scope of its conclusions. First, the cross-sectional design precludes causal inference: temporal ordering cannot be established, reverse or reciprocal relationships remain possible, and the PLS-SEM structural paths should be interpreted as conditional associations within the specified model rather than as evidence that the predictors causally produce changes in e-participation or perceived platform effectiveness. Second, the principal constructs were measured through self-report within a single survey instrument, creating the possibility of common method bias as well as reporting and recall error. Although Harman's single-factor test and the marker-variable analysis did not indicate substantial common method variance in this dataset, these diagnostic procedures cannot rule out common method bias entirely; moreover, self-reported participation may diverge from administrative records of actual activity. Third, the non-probability quota sampling, although designed to improve coverage across locality and income categories, limits statistical generalisability to the broader Malaysian population and cross-national comparison. In particular, because eligibility required prior use of a government online channel and the achieved sample skews younger and more highly educated, all findings pertain to users of government digital platforms; non-users—the group most exposed to first-level exclusion—lie outside the sampling frame, so the digital-divide associations estimated here may understate barriers in the population at large. Fourth, the fsQCA analysis is bounded by the conditions included in the model; conditions not captured here—such as political efficacy, platform design quality, or prior participation experience—may function as necessary conditions or as components of sufficient configurations that the current specification cannot identify. Political efficacy deserves particular emphasis (Lai & Beh, 2025): the low procedural-trust mean may partly reflect an efficacy deficit that the model cannot identify. A brief two-item exploratory efficacy measure included in the instrument (Spearman–Brown = .63) showed no association with procedural trust or participation (both $r \leq .03$) and a null coefficient when added to the structural model ($\beta = .02$, n.s.); given its brevity and modest reliability, no conclusions are drawn from this null result, and future studies should employ validated internal and external efficacy scales. Fifth, with eighteen interaction terms tested under family-wise correction, the design is underpowered for detecting small moderation effects; the null moderation pattern should therefore be read as limited evidence under this specification rather than as conclusive evidence of absence. Future research should address these limitations through several complementary strategies. Longitudinal panel designs would allow examination of how trust and risk perceptions evolve in response to platform changes and data governance events. Experimental designs, such as trust-priming interventions or information provision experiments, would strengthen causal inference about mechanisms linking risk perceptions to participation. Cross-national replication of the fsQCA analysis across ASEAN e-participation contexts—which vary substantially in administrative culture, digital infrastructure maturity, and trust environments—would assess the generalisability of the configurational pathways identified here and establish which conditions are context-specific and which transcend national governance arrangements. More broadly, the integration of PLS-SEM and fsQCA offers a methodological contribution to participatory governance research. The present study demonstrates that integrating set-theoretic analysis with variance-based structural modeling can reveal configurational insights—about which combinations of conditions are sufficient, which are necessary, and which characterise non-participation—that are invisible to linear analysis alone. This dual-method approach is particularly valuable when theoretical expectations are that configurational pathways to the outcome are heterogeneous and that multiple distinct citizen segments may achieve the same participatory outcome through fundamentally different combinations of enabling conditions.

Author Contributions

Jiaqi Liu led the conceptualisation, data collection, formal analysis, and preparation of the original draft. Nur Ajrun Khalid supervised the research, validated the analytical approach and findings, and contributed to interpretation and substantive revision. Both authors reviewed and approved the final manuscript.

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Appendix A. Measurement Items

Scale A: 1 = strongly disagree to 7 = strongly agree. Scale B: 1 = never to 7 = extremely often (past twelve months). All main constructs are reflective. Items were adapted from the sources reported in Section 3.2; no items were deleted during pilot testing or measurement validation. The questionnaire also included auxiliary, control, marker-variable, quality-check, and demographic items that were not part of the main structural model.

Physical access (PA) — Scale A

P1. I have access to a suitable device (smartphone/computer/tablet) for government online tasks.

P2. I have reliable internet access when I need to use government online platforms.

P3. My internet connection is stable enough for tasks like logging in, filling forms, and uploading documents.

Affordability constraint (AFF) — Scale A

F1. The cost of internet/data limits how often I can use government online platforms.

F2. I sometimes avoid using government online platforms because using data/internet is expensive.

F3. To maintain online participation, I need to cut back on non-essential spending or budget more tightly.

Digital skills (DS) — Scale A

S1. I can complete online forms and upload documents without difficulty.

S2. I can manage account security measures (e.g., passwords, verification codes, 2FA) when needed.

S3. I can adjust privacy/security settings on apps or websites when needed.

S4. I can judge whether a link/website is legitimate (not a scam/fake).

Privacy risk (PR) — Scale A

PR1. I worry that my personal data may be used beyond the original purpose (purpose creep) on government platforms.

PR2. I worry that my data may be shared with other agencies or third parties without my explicit consent.

PR3. I worry that government platforms may collect more personal data than necessary.

Security risk (SR) — Scale A

SR1. I worry that my account could be hijacked or impersonated.

SR2. I worry that vulnerabilities could lead to data breaches.

SR3. I worry that my submissions/transactions may not be fully secure.

Misinformation/manipulation risk (MR) — Scale A

MR1. I worry that misinformation can distort my understanding of government policies/services.

MR2. I worry that online discussions can be manipulated (e.g., coordinated influence).

MR3. I worry that AI-generated fake content (e.g., deepfakes or synthetic news) could mislead public opinion about government issues.

Institutional trust (IT) — Scale A

IT1. Government agencies handle citizens' personal data responsibly.

IT2. Government agencies comply with relevant privacy/data-protection requirements.

IT3. If a serious data/security incident occurs, agencies will respond transparently and take corrective action.

IT4. Misuse of citizens' data by government staff would be investigated and sanctioned.

IT5. Government agencies prioritize public interest when managing digital services.

Technology trust (TT) — Scale A

TT1. Government online platforms are technically secure.

TT2. Government online platforms are reliable and function as intended.

TT3. Government platforms have adequate safeguards (e.g., authentication, encryption).

TT4. Government platforms can protect users against common cyber threats (e.g., account takeover).

Procedural trust and responsiveness (PTR) — Scale A

PTR1. The process for submitting online feedback/complaints is clear and transparent.

PTR2. Online submissions are handled fairly, not merely as a formality.

PTR3. I can usually track progress or receive a meaningful response after submitting feedback online.

PTR4. When policies/services are finalized, I can see how public online suggestions were acknowledged or responded to.

PTR5. Agencies take online feedback seriously when improving services or policies.

Perceived platform effectiveness (PPE) — Scale A

PPE1. Government online platforms make it easier to access public information and services.

PPE2. They improve efficiency (save time, reduce in-person visits).

PPE3. They are usable for people with different digital skill levels.

PPE4. Overall, they are effective tools for citizen–government interaction.

E-participation behaviour (EP) — Scale B

COM1. Submitted feedback/suggestions through official online channels.

COM2. Submitted complaints/service reports through official online channels.

COM3. Participated in online consultations/surveys/polls about public issues.

COM4. Interacted with official government accounts online (comments/messages/live Q&A) regarding public issues.

Auxiliary: usage intensity (U; not in the structural model) — Scale A

U1. I frequently use government online platforms to obtain official information (guidelines, requirements, announcements).

U2. I frequently use government online platforms to complete public services (applications, appointments, payments, downloads).

U3. Government online platforms are one of my main channels for handling government-related tasks.

Auxiliary: civic/political efficacy (EFC; supplementary analysis only) — Scale A

EFC1. Ordinary citizens can influence public decisions.

EFC2. My input can be heard if I express it through appropriate channels.

Auxiliary: marker variable (MV; common-method check only) — Scale A

MV1. I think local weather forecasts are generally accurate.

MV2. Weather forecast apps/websites are reliable for planning my day.

MV3. I often trust weather forecasts when making daily decisions.

Appendix B. Trust × Risk Interaction Terms (Full Results)

Two-stage approach: each product of standardised latent-variable scores added in turn to the full main-effects model (n = 339).

Appendix Table B1. Trust × Risk Interaction Terms for E-Participation

Interaction	β	SE	95% CI	p	p (HC3)	f^2
IT×PR	.014	.047	[−.079, .107]	.768	.766	.000
IT×SR	.054	.050	[−.045, .153]	.286	.345	.004
IT×MR	.113	.052	[.011, .214]	.030	.053	.015
TT×PR	.017	.048	[−.079, .112]	.730	.748	.000
TT×SR	−.027	.047	[−.120, .066]	.569	.572	.001
TT×MR	−.000	.047	[−.092, .091]	.993	.993	.000
PTR×PR	−.014	.050	[−.113, .085]	.787	.776	.000
PTR×SR	.025	.048	[−.070, .120]	.608	.600	.001
PTR×MR	−.009	.047	[−.100, .083]	.855	.858	.000

Appendix Table B2. Trust × Risk Interaction Terms for Perceived Platform Effectiveness

Interaction	β	SE	95% CI	p	p (HC3)	f^2
IT×PR	.032	.047	[−.060, .124]	.498	.536	.001
IT×SR	.070	.050	[−.029, .168]	.164	.160	.006
IT×MR	.005	.052	[−.097, .106]	.930	.932	.000
TT×PR	.116	.048	[.022, .209]	.015	.016	.018

TT×SR	.069	.047	[−.023, .161]	.139	.192	.007
TT×MR	.026	.046	[−.065, .117]	.572	.583	.001
PTR×PR	.001	.050	[−.097, .099]	.981	.981	.000
PTR×SR	.046	.048	[−.048, .140]	.332	.337	.003
PTR×MR	.040	.046	[−.051, .130]	.391	.358	.002

Note. Bonferroni-corrected α = .05/18 = .003: no term is significant after correction; all $f^2 \leq .018$.

Appendix C. Latent-Score OLS Robustness Models With and Without Demographic Controls

Controls: sixteen dummies for gender (4 categories), age band (5), education (5), residential area (3), and income (4, including "prefer not to say"). R^2: e-participation .255 → .294; platform effectiveness .270 → .348. These are latent-score OLS robustness models; primary hypothesis testing remains based on the SmartPLS bootstrap results in Table 1.

Outcome	Predictor	β (OLS base)	p (OLS base)	β (OLS + controls)	p (OLS + controls)	Δβ
E-participation	PA	.276	<.001	.277	<.001	.000
E-participation	AFF	−.089	.064	−.104	.034	−.015
E-participation	DS	.146	.002	.123	.012	−.023
E-participation	PR	−.185	<.001	−.221	<.001	−.035
E-participation	SR	−.113	.019	−.108	.032	.005
E-participation	MR	−.135	.005	−.167	.001	−.031
E-participation	IT	.156	.001	.147	.003	−.009
E-participation	TT	.188	<.001	.180	<.001	−.007
E-participation	PTR	.048	.314	.067	.165	.019
Platform effectiveness	PA	.257	<.001	.262	<.001	.005
Platform effectiveness	AFF	−.118	.014	−.139	.003	−.022
Platform effectiveness	DS	.237	<.001	.203	<.001	−.033
Platform effectiveness	PR	−.155	.001	−.173	<.001	−.018
Platform effectiveness	SR	−.165	.001	−.138	.004	.028
Platform effectiveness	MR	−.200	<.001	−.227	<.001	−.027
Platform effectiveness	IT	.105	.028	.110	.020	.006
Platform effectiveness	TT	.063	.184	.080	.088	.017
Platform effectiveness	PTR	.032	.495	.058	.211	.026

Note. Significant controls in the OLS robustness models include T20 income (positive, both outcomes); for platform effectiveness, female gender (positive), Master's-level education (negative), and rural residence (negative) are also significant. No main path changes sign after adding controls; p-values in this appendix should not be compared mechanically with Table 1 because the estimator and inferential procedure differ.

