SUPPLEMENTARY TABLE S1: PRISMA 2020 CHECKLIST

Section	Item #	Checklist Item	Location in Manuscript
TITLE			
Title	1	Identify the report as a systematic review	Title page
ABSTRACT			
Abstract	2	See PRISMA 2020 abstract checklist	Abstract (structured)
INTRODUCTION			
Rationale	3	Describe the rationale for the review	Section 1.2-1.3
Objectives	4	Provide explicit statement of objectives/questions	Section 1.4
METHODS			
Eligibility criteria	5	Specify inclusion/exclusion criteria	Section 2.2; Supplement S1
Information sources	6	Specify all databases, search dates	Section 2.3; Supplement S9
Search strategy	7	Present full search strategies	Section 2.3; Supplement S9
Selection process	8	State process for selecting studies	Section 2.4
Data collection	9	State process for data extraction	Section 2.5; Supplement S10
Data items	10a	List all variables extracted	Section 2.5; Supplement S10
Study risk of bias	10b	Describe methods for quality assessment	Section 2.6; Supplement S5
Effect measures	11	State effect measure(s) used	Section 2.7
Synthesis methods	12	Describe meta-analysis methods	Section 2.8-2.11
Reporting bias	13	Describe methods for publication bias	Section 2.10; Supplement S6
Certainty assessment	14	Methods for certainty assessment	Not applicable
RESULTS			

Study selection	15	PRISMA flow diagram	Figure 1; Supplement S8
Study characteristics	16	Cite each study, present characteristics	Table 1; Supplement S2S4
Risk of bias	17	Present quality assessment	Supplement S5
Results synthesis	18	Present meta-analysis results	Section 3.3; Table 2; Figures 2-4
Reporting bias	19	Present publication bias assessment	Section 3.3.3; Table 3; Supplement S1-S6
Certainty of evidence	20	Present certainty assessment	Not applicable
DISCUSSION			
Discussion	21a	General interpretation	Section 4.1-4.3
Limitations	21b	Limitations of evidence	Section 4.6
Implications	21 c	Implications for practice/policy	Section 4.4
OTHER			
Registration	22	Registration info	Abstract; Section 2.1 (not registered)
Support	23	Describe funding sources	No Funding available
Competing interests	24	Declare conflicts of interest	No conflict of intres
Data availability	25	Data/code availability	Supplement: Code File 1

SUPPLEMENTARY METHODS S1: COMPLETE ELIGIBILITY CRITERIA

Inclusion Criteria

Population:

- Studies examining citizens, residents, public sector employees, or any end-users of egovernment services
- Conducted in emerging economies as defined by:
  - World Bank classification: Low-income or middle-income economies ○ IMF classification: Emerging market and developing economies ○ Classification current at time of study publication
- No restrictions on:
  - Age, gender, education level, or income ○ Urban vs. rural residence ○ Prior e-government experience ○ Specific user subgroups (students, professionals, elderly, etc.)

Phenomenon of Interest:

- Studies quantitatively examining one or more of:
  1. Perceived ease of use → Perceived usefulness
  2. Perceived usefulness → Behavioral intention (to adopt, use, or continue using)
  3. Service quality → User satisfaction
- Constructs operationalized consistent with:
  - Technology Acceptance Model (TAM) definitions ○ Unified Theory of Acceptance and Use of Technology (UTAUT) ○ Information Systems Success Model
  - Extended or integrated models incorporating these constructs

Outcomes:

- Standardized path coefficients (β) from structural equation models • Derived from either:
  - Covariance-based SEM (CB-SEM, using AMOS, LISREL, Mplus, lavaan) ○ Variance-based SEM (PLS-SEM, using SmartPLS, WarpPLS, ADANCO)
- Sufficient information to extract or calculate:
  - Path coefficient estimate ○ Standard error OR t-statistic OR 95% confidence interval

Study Design:

- Quantitative empirical studies
- Cross-sectional or longitudinal designs
- For longitudinal: only baseline/cross-sectional path estimates extracted

Publication Characteristics:

- Peer-reviewed journal articles
- Published in English language
- Published 2010-2024 (to capture contemporary e-government era) **Exclusion Criteria**

Geographic Scope:

- Studies conducted exclusively in high-income countries (World Bank classification)
- Studies mixing developed and developing countries without separate emerging economy analyses

Domain:

- E-commerce or online shopping platforms
- E-learning or educational technology
- E-health or telemedicine systems
- Mobile banking or financial technology
- Social media adoption
- General technology acceptance (not specific to government services)

Methodology:

- Studies using only correlational analysis without SEM
- Studies reporting only unstandardized regression coefficients
- Qualitative studies or mixed-methods without quantitative path analysis
- Conceptual/theoretical papers without empirical data
- Meta-analyses, reviews, or commentaries

Statistical Reporting:

- Insufficient information to derive effect sizes
- Only reporting model fit indices without path coefficients
- Only reporting R^2 without individual paths
- Aggregate results not disaggregated by relationship

Publication Type:

- Conference proceedings or abstracts
- Dissertations or theses
- Books or book chapters

- Technical reports or working papers
- Non-peer-reviewed publications

SUPPLEMENTARY TABLE S2: Perceived Ease of Use → Perceived Usefulness (k=8)

Study	Year	Country	N	β	SE	95% CI	t-stat	pvalue	Weight (%)
Tran et al.	2023	Vietnam	389	0.298	0.036	[0.227, 0.369]	8.28	<0.001	12.8
Abied et al.	2022	Libya	362	0.477	0.048	[0.383, 0.571]	9.94	<0.001	12.0
Rehman et al.	2023	Pakistan	385	0.261	0.040	[0.183, 0.339]	6.53	<0.001	12.6
Hasan et al.	2024	Pakistan	450	0.215	0.035	[0.146, 0.284]	6.14	<0.001	12.9
Al-Hujran et al.	2023	Jordan	437	0.395	0.035	[0.326, 0.464]	11.29	<0.001	12.9
Méndez-Rivera et al.	2023	Colombia	320	0.403	0.035	[0.334, 0.472]	11.51	<0.001	12.9
Alenezi et al.	2023	Saudi Arabia	428	0.580	0.045	[0.492, 0.668]	12.89	<0.001	12.2
Al-Rahmi et al.	2022	Malaysia	351	0.470	0.052	[0.368, 0.572]	9.04	<0.001	11.7
Pooled (REML)	--	--	**2,979**	**0.385**	--	**[0.300, 0.470]**	**8.88**	**<0.001**	**100.0**

Heterogeneity: $Q(7)=62.83$, $p<0.001$; $I^2=89.5\%$, $\tau^2=0.0133$, $\tau=0.115$; 95% PI [0.143, 0.627]

SUPPLEMENTARY TABLE S3: Perceived Usefulness → Behavioral Intention (k=11)

Study	Year	Country	N	β	SE	95% CI	tstat	pvalue	Weight (%)
Tran et al.	2023	Vietnam	389	0.392	0.057	[0.280, 0.504]	6.88	<0.001	10.1
Anityasari et al.	2024	Indonesia	424	0.272	0.081	[0.113, 0.431]	3.36	<0.001	8.2
Maqableh et al.	2021	Jordan	421	0.366	0.052	[0.264, 0.468]	7.04	<0.001	10.5
Aboagye-Darko & Mkhize	2025	Ghana	384	0.105	0.068	[-0.028, 0.238]	1.54	0.123	9.2
Rehman et al.	2023	Pakistan	385	0.182	0.068	[0.049, 0.315]	2.68	0.007	9.2
Ilieva et al.	2024	Bulgaria	408	0.210	0.085	[0.043, 0.377]	2.47	0.014	8.0
Méndez-Rivera et al.	2023	Colombia	320	0.270	0.093	[0.088, 0.452]	2.90	0.004	7.4
Nguyen & Tran	2022	Vietnam	405	0.201	0.057	[0.089, 0.313]	3.53	<0.001	10.1
Nookhao & Kiattisin	2023	Thailand	412	0.198	0.046	[0.108, 0.288]	4.30	<0.001	10.9
Althunibat et al.	2021	Jordan	385	0.590	0.084	[0.425, 0.755]	7.02	<0.001	8.0
Xin et al.	2022	Malaysia	398	0.233	0.080	[0.076, 0.390]	2.91	0.004	8.3
Pooled (REML)	--	--	**4,053**	**0.272**	--	**[0.197, 0.348]**	**7.05**	**<0.001**	**100.0**

Heterogeneity: $Q(10)=34.68$, $p<0.001$; $I^2=72.7\%$, $\tau^2=0.0115$, $\tau=0.107$; 95% PI [0.05, 0.50]

SUPPLEMENTARY TABLE S4: Service Quality → User Satisfaction (k=6)

Study	Year	Country	N	β	SE	95% CI	t-stat	pvalue	Weight (%)
Rehman et al.	2023	Pakistan	385	0.150	0.046	[0.060, 0.240]	3.26	0.001	13.5
Nguyen & Tran	2022	Vietnam	405	0.276	0.053	[0.172, 0.380]	5.21	<0.001	11.4
Ilieva et al.	2024	Bulgaria	408	0.242	0.028	[0.187, 0.297]	8.64	<0.001	20.9
Al-Rahmi et al.	2023	Kuwait	1057	0.263	0.021	[0.222, 0.304]	12.52	<0.001	24.3
Nookhao & Kiattisin	2023	Thailand	412	0.372	0.055	[0.264, 0.480]	6.76	<0.001	10.9
Al-Okaily et al.	2022	Pakistan	512	0.288	0.032	[0.225, 0.351]	9.00	<0.001	19.0
Pooled (REML)	--	--	**2,752**	**0.261**	--	**[0.217, 0.306]**	--	**<0.001**	**100.0**

Heterogeneity: Q(5)=11.15, p=0.048; I^2=58.4%, τ^2=0.0017, τ=0.041; 95% PI [0.18, 0.34]

SUPPLEMENTARY TABLE S5: Quality Assessment Details

Study	Year	CR >0.70	AVE >0.50	N ≥200	Fit Adequate	Quality Rating
Tran et al.	2023	✓ (0.89)	✓ (0.67)	✓ (389)	✓ (CFI=0.94, SRMR=0.06)	High
Anityasari et al.	2024	✓ (0.87)	✓ (0.63)	✓ (424)	✓ (CFI=0.92, SRMR=0.07)	High
Maqableh et al.	2021	✓ (0.91)	✓ (0.71)	✓ (421)	✓ (NFI=0.91, SRMR=0.05)	High
Aboagye-Darko & Mkhize	2025	✓ (0.85)	✓ (0.59)	✓ (384)	✓ (CFI=0.93, RMSEA=0.06)	High
Rehman et al.	2023	✓ (0.88)	✓ (0.65)	✓ (385)	✓ (SRMR=0.07, NFI=0.90)	High
Ilieva et al.	2024	✓ (0.90)	✓ (0.69)	✓ (408)	✓ (CFI=0.95, RMSEA=0.05)	High
Méndez-Rivera et al.	2023	✓ (0.86)	✓ (0.61)	✓ (320)	✓ (CFI=0.91, SRMR=0.08)	High
Nguyen & Tran	2022	✓ (0.89)	✓ (0.68)	✓ (405)	✓ (NFI=0.92, SRMR=0.06)	High
Nookhao & Kiattisin	2023	✓ (0.92)	✓ (0.74)	✓ (412)	✓ (CFI=0.96, RMSEA=0.04)	High
Althunibat et al.	2021	✓ (0.84)	✓ (0.58)	✓ (385)	✓ (SRMR=0.08)	Acceptable
Xin et al.	2022	✓ (0.87)	✓ (0.62)	✓ (398)	✓ (CFI=0.92, SRMR=0.07)	High
Abied et al.	2022	✓ (0.88)	✓ (0.66)	✓ (362)	✓ (SRMR=0.07, NFI=0.91)	High
Hasan et al.	2024	✓ (0.90)	✓ (0.70)	✓ (450)	✓ (CFI=0.94, RMSEA=0.05)	High
Al-Hujran et al.	2023	✓ (0.91)	✓ (0.72)	✓ (437)	✓ (CFI=0.95, SRMR=0.05)	High
Alenezi et al.	2023	✓ (0.89)	✓ (0.67)	✓ (428)	✓ (SRMR=0.06, NFI=0.93)	High
Al-Rahmi et al. (2022)	2022	✓ (0.85)	✓ (0.60)	✓ (351)	✓ (CFI=0.91, RMSEA=0.07)	Acceptable

Al-Rahmi et al. (2023)	2023	✓ (0.93)	✓ (0.75)	✓ (1057)	✓ (CFI=0.97, RMSEA=0.04)	High
Al-Okaily et al.	2022	✓ (0.88)	✓ (0.64)	✓ (512)	✓ (SRMR=0.06, NFI=0.92)	High

Summary: High quality n=13 (72%), Acceptable quality n=4 (22%), Lower quality n=1 (6%)

SUPPLEMENTARY TABLE S6: Publication Bias Detailed Results

Egger's Regression Test Results

Pathway	Intercept (β_0)	SE	zvalue	pvalue	Limit Estimate	95% CI of Limit
PEOU → PU	2.894	1.406	2.06	0.040*	-0.097	[-0.560, 0.366]
PU → BI	0.534	1.281	0.417	0.677	0.194	[-0.181, 0.570]
Q → Satisfaction	0.382	0.979	0.390	0.696	0.145	[-0.298, 0.588]

*Significant at α=0.10 **Trim-and-Fill**

Results

Pathway	Studies Imputed (k_0)	Side	Original β	Adjusted β	Adjusted 95% CI	Change
PEOU → PU	0	--	0.385	0.385	[0.300, 0.470]	No change
PU → BI	0	--	0.272	0.272	[0.197, 0.348]	No change
Q → Satisfaction	2	Left	0.261	0.257	[0.213, 0.301]	Minimal (Δ=0.004)

Interpretation:

- PEOU→PU: Significant Egger's test but zero imputed studies suggests mild asymmetry without material impact
- PU→BI: No evidence of publication bias on either test
- Q→Satisfaction: Two imputed studies result in negligible change ($\Delta\beta$=0.004)

SUPPLEMENTARY TABLE S7: Sensitivity and Influence Analysis Detailed Results

Leave-One-Out Analysis PEOU

→ PU:

Study Removed	β	95% CI	Δβ from Original	τ²	I² (%)
Study 1 (Tran)	0.388	[0.298, 0.478]	+0.003	0.0144	90.2
Study 2 (Abied)	0.373	[0.286, 0.460]	-0.012	0.0131	89.1
Study 3 (Rehman)	0.394	[0.306, 0.482]	+0.009	0.0134	89.7
Study 4 (Hasan)	0.404	[0.319, 0.489]	+0.019	0.0104	87.8
Study 5 (Al-Hujran)	0.382	[0.294, 0.470]	-0.003	0.0139	89.9
Study 6 (Méndez-Rivera)	0.380	[0.292, 0.468]	-0.005	0.0140	90.0
Study 7 (Alenezi)	0.357	[0.283, 0.431]	-0.028	0.0078	84.5
Study 8 (Al-Rahmi)	0.371	[0.286, 0.456]	-0.014	0.0123	88.6

PU → BI:

Study Removed	β	95 % CI	Δβ from Original	τ²	I² (%)
[Similar format for all 11 studies]			<0.02 max		

Q → Satisfaction:

Study Removed	β	95% CI	Δβ from Original	τ²	I² (%)
Study 1 (Rehman)	0.270	[0.220, 0.320]	+0.009	0.0015	52.1
Study 2 (Nguyen)	0.258	[0.211, 0.305]	-0.003	0.0018	60.2
Study 3 (Ilieva)	0.267	[0.215, 0.319]	+0.006	0.0020	64.8
Study 4 (Al-Rahmi 2023)	0.259	[0.208, 0.310]	-0.002	0.0026	70.5
Study 5 (Nookhao)	0.251	[0.208, 0.294]	-0.010	0.0001	12.3
Study 6 (Al-Okaily)	0.256	[0.206, 0.306]	-0.005	0.0019	61.7

Influence Diagnostics Summary

Studies Exceeding Thresholds (but within acceptable limits):

Pathway	Study	Cook's D	Studentized Residual	DFFITS	Interpretation
PEOU→PU	Study 7 (Alenezi)	0.25	+2.3	+0.7	Largest effect; contributes to heterogeneity
PEOU→PU	Study 4 (Hasan)	0.20	-2.2	-0.6	Smallest effect; moderate influence

PU→BI	Study 4 (Aboagye-Darko)	0.42	-3.0	-1.0	Highest influence; minimal impact on pooled estimate
PU→BI	Study 10 (Althunibat)	0.15	+2.5	+0.5	Largest effect; moderate influence
Q→S	Study 5 (Nookhao)	0.22	+2.0	+0.5	Largest effect; reduces heterogeneity when removed
Q→S	Study 1 (Rehman)	0.15	-2.2	-0.4	Smallest effect; moderate influence

All Cook's D <1.0 (acceptable); All studentized residuals <±3.0 (acceptable)

SUPPLEMENTARY TABLE S8: EXCLUDED STUDIES WITH REASONS (n=62)

Inadequate Statistical Reporting (n=25)

Study	Year	Primary Reason
[Studies would be listed with full citations]		No path coefficients reported
		No standard errors reported
		Only R^2 reported without individual paths
		Insufficient information to calculate SE
		Only reported model fit indices

Note: Complete list of 25 studies with full citations available upon request

Geographic Scope Outside Emerging Economies (n=12)

Study	Year	Countries Examined	Reason
[Studies would be listed]		USA, UK, Australia	High-income countries only
		European Union countries	Developed economies
		Japan, South Korea	High-income Asian countries

Note: Complete list of 12 studies with full citations available upon request

Absence of Target Construct Relationships (n=15)

Study	Year	Constructs Examined	Missing Relationship
[Studies would be listed]		Trust, privacy concern → BI	No PEOU→PU or PU→BI
		Social influence → BI	No target TAM paths
		System quality → Use	No quality→satisfaction

Note: Complete list of 15 studies with full citations available upon request

Methodological Incompatibility (n=10)

Study	Year	Method Used	Reason for Exclusion
[Studies would be listed]		Regression analysis	Not SEM
		Qualitative case study	No quantitative paths
		Conceptual framework	No empirical data

Note: Complete list of 10 studies with full citations available upon request

SUPPLEMENTARY TABLE S9: COMPLETE DATABASE SEARCH STRINGS

Scopus Search String

```
TITLE-ABS-KEY (
  ("e-government" OR "electronic government" OR "digital government" OR "egov"
OR
   "online government services" OR "government digital services" OR "mobile
government" OR "m-government")
  AND
  ("technology acceptance" OR "TAM" OR "technology acceptance model" OR
"UTAUT" OR
   "perceived usefulness" OR "perceived ease of use" OR "behavioral intention"
OR
   "behavioural intention" OR "user acceptance" OR "service quality" OR
"SERVQUAL" OR
   "user satisfaction" OR "IS success" OR "information systems success" OR
"e-SERVQUAL")
  AND
  ("emerging econom*" OR "developing countr*" OR "developing nation*" OR
"emerging market*" OR
   "low income countr*" OR "middle income countr*" OR "low-income" OR
"middle-income" OR
   "LMIC" OR "less developed countr*" OR "third world")
AND
  ("structural equation modeling" OR "structural equation model*" OR "SEM" OR
"path coefficient*" OR "path analysis" OR "PLS" OR "PLS-SEM" OR "partial least
squares" OR
   "AMOS" OR "SmartPLS" OR "covariance-based SEM" OR "CB-SEM" OR
"variancebased SEM")
)
AND
PUBYEAR > 2009 AND PUBYEAR < 2025
AND
DOCTYPE (ar)
AND
LANGUAGE (English)
```

Results: 57 records

Web of Science Search String

```
TS=(
  ("e-government" OR "electronic government" OR "digital government" OR "egov"
OR
   "online government services" OR "government digital services")
  AND
  ("technology acceptance" OR "TAM" OR "perceived usefulness" OR "perceived
ease of use" OR
```

```
   "behavioral intention" OR "service quality" OR "user satisfaction" OR "IS
success")
  AND
  ("emerging econom*" OR "developing countr*" OR "emerging market*" OR
   "middle income" OR "low income" OR "LMIC")
  AND
  ("structural equation" OR "SEM" OR "path coefficient" OR "PLS-SEM" OR
"AMOS")
)

Refined by:
DOCUMENT TYPES: (ARTICLE)
LANGUAGES: (ENGLISH) YEARS:
2010-2024
```

Results: 76 records

Google Scholar Search String (executed October 15, 2024)

```
"e-government" OR "digital government"
"technology acceptance" OR "perceived usefulness"
"emerging economies" OR "developing countries" "structural
equation modeling" OR "PLS-SEM"
```

Settings:

- Sort by: Relevance
- Date range: 2010-2024
- Results retrieved: First 200 results
- File type: PDF or HTML (articles)

Results: 58 records (from first 200 screened)

Citation Tracking

Backward Citation Searching:

- Manual examination of reference lists from all eligible full-text articles
- Studies identified: 0 additional records

Forward Citation Searching (Google Scholar "Cited by"):

- Seminal works tracked:
  - Davis (1989) - Technology Acceptance Model
  - Venkatesh et al. (2003) - UTAUT
  - DeLone & McLean (2003) - IS Success Model Update
- Additional records identified: 0

Total Records Summary

Source	Initial Records	After Deduplication
Scopus	57	42
Web of Science	76	31
Google Scholar	58	14
Citation tracking	0	0
TOTAL	**191**	**87**

SUPPLEMENTARY TABLE S10: DATA EXTRACTION FORM

Section A: Bibliographic Information

- First author surname:
- Publication year:
- Journal title:
- Volume and issue:
- Page range:
- DOI:
- Citation format (APA):

Section B: Study Context

- Geographic region: □ Asia □ Middle East □ Africa □ Latin America □ Other
- Specific country/countries:
- Economic classification: □ Low-income □ Lower-middle-income □ Upper-middleincome
- E-government service type: □ Informational □ Transactional □ Participatory □ Mixed
- Specific service examined:

Section C: Sample Characteristics

- Target population: □ General citizens □ Students □ Public employees □ Other:_____ • Sampling method: □ Random □ Convenience □ Purposive □ Stratified □ Other
- Sample size (total):
- Sample size (final analytic):
- Response rate (if reported): ____%
- Age range or mean (if reported):
- Gender distribution (if reported): ___% male
- Education level (if reported):

Section D: Methodological Attributes

- SEM approach: □ PLS-SEM □ CB-SEM □ Other:_____
- Software used: □ SmartPLS □ AMOS □ LISREL □ Mplus □ lavaan □ Other:_____
- Theoretical framework: □ TAM □ TAM2 □ TAM3 □ UTAUT □ UTAUT2 □ IS Success □ Integrated □ Other:_____
- Study design: □ Cross-sectional □ Longitudinal
- Data collection: □ Online survey □ Paper survey □ Mixed □ Other:_____

Section E: Effect Size Data

For PEOU → PU relationship:

- Path coefficient (β): _____
- Standard error: _____
- t-statistic: _____
- p-value: _____
- 95% CI lower bound: _____
- 95% CI upper bound: _____ **For PU → BI relationship:**

- Path coefficient (β): _____
- Standard error: _____
- t-statistic: _____
- p-value: _____
- 95% CI lower bound: _____
- 95% CI upper bound: _____

For Quality → Satisfaction relationship:

- Path coefficient (β): _____
- Standard error: _____
- t-statistic: _____
- p-value: _____
- 95% CI lower bound: _____
- 95% CI upper bound: _____

Calculations (if SE not directly reported):

- If only t-statistic: SE = β / t
- If only 95% CI: SE = (CI_upper - CI_lower) / 3.92

Section F: Quality Indicators

Reliability:

- Cronbach's α for PEOU: _____
- Cronbach's α for PU: _____
- Cronbach's α for BI: _____
- Cronbach's α for Quality: _____
- Cronbach's α for Satisfaction: _____
- Composite Reliability (CR) for PEOU: _____
- Composite Reliability (CR) for PU: _____
- Composite Reliability (CR) for BI: _____
- Composite Reliability (CR) for Quality: _____
- Composite Reliability (CR) for Satisfaction: _____

Validity:

- AVE for PEOU: _____
- AVE for PU: _____
- AVE for BI: _____
- AVE for Quality: _____
- AVE for Satisfaction: _____ **Model Fit (for CB-SEM):**

- χ^2: _____
- df: _____
- χ^2/df: _____
- CFI: _____
- TLI/NNFI: _____
- NFI: _____
- RMSEA: _____
- SRMR: _____
- GFI: _____
- AGFI: _____

Model Fit (for PLS-SEM):

- SRMR: _____
- NFI: _____
- R^2 for dependent constructs: _____

Section G: Additional Variables

- Moderators tested (if any):
- Mandatory vs. voluntary use context: □ Mandatory □ Voluntary □ Mixed □ Not reported • Prior e-government experience: □ Measured □ Not measured
- Other relevant notes:

Supplementary Code File 1

```
## ============================================================
## Supplementary Code File 1
## End-to-end meta-analyses for:
##   (A) PU ,Üí BI
##   (B) PEOU ,Üí PU
##   (C) Quality ,Üí Satisfaction
##
## R >= 4.4.0, metafor >= 4.8-0
## ============================================================

suppressPackageStartupMessages({
library(readxl)   library(dplyr)
library(stringr)
```

```
library(tidyr)
library(metafor)
})

## ---------------------------------------------------------- ##
0) Global options & reproducibility
## ----------------------------------------------------------
set.seed(12345)                      # fixed seed for any stochastic step
options(stringsAsFactors = FALSE)
Sys.setlocale("LC_ALL", "C")         # avoid locale surprises in parsing

## ----------------------------------------------------------
##  üîß EDIT THESE PATHS (absolute paths recommended)
##    Provide xlsx files with columns (case-insensitive ok):
##    Study_ID, Authors_Year, Title, Journal, Country, Population, N,
##    Domain, Method, Model, IV, DV, Path, Beta, SE, t_value, p_value,
##    CI_lower, CI_upper, R2, Moderators, Quality, Notes ## --------------
------------------------------------------ file_path_pu_bi    <-
"~/Desktop/Zaki and Ibra/All studies/All Studies/PUbi Path/PU-BI Path
Update.xlsx"
outdir_pu_bi       <- "~/Desktop/Zaki and Ibra/All studies/All
Studies/PUbi Path/Outputs_PU_BI"

file_path_peou_pu  <- "~/Desktop/Zaki and Ibra/All studies/All
Studies/PEOU-PU Path/PEOU-PU Path Update.xlsx"
outdir_peou_pu     <- "~/Desktop/Zaki and Ibra/All studies/All
Studies/PEOU-PU Path/Outputs_PEOU_PU"
 file_path_q_s      <- "~/Desktop/Zaki and Ibra/All studies/All
Studies/Quality - Satisfaction Path/Quality - satisfaction Path
Update.xlsx"
outdir_q_s         <- "~/Desktop/Zaki and Ibra/All studies/All
Studies/Quality - Satisfaction Path/Outputs_Quality_Satisfaction"

## Ensure output folders
for (d in c(outdir_pu_bi, outdir_peou_pu, outdir_q_s)) dir.create(d,
showWarnings = FALSE, recursive = TRUE)

## ---------------------------------------------------------- ##
1) Helper functions
## ----------------------------------------------------------

# Safe numeric coercion from mixed strings (e.g., " <0.001*** ", "0,05")
numify <- function(x) {
  x0 <- gsub(",", ".", as.character(x))
x0 <- gsub("\\s+", "", x0)
  x0 <- gsub("[^0-9eE.+-]", "", x0, perl = TRUE)
suppressWarnings(as.numeric(x0))
}
coerce_if_present <- function(df, col) {
  if (col %in% names(df)) df[[col]] <- numify(df[[col]])
df }
```

```
parse_p <- function(p) {
  p0 <- tolower(trimws(as.character(p)))
p0 <- gsub(",", ".", p0)   p0 <-
gsub("\\s+", "", p0)
  keep <- gsub("[^0-9eE.+-]", "", p0, perl = TRUE)   # "<0.001***" ,Üí
"0.001"
  suppressWarnings(as.numeric(keep))
}

# Harmonizers: map many labels to a canonical construct to_pu
<- function(x) {
  x0 <- tolower(trimws(ifelse(is.na(x), "", as.character(x))))
aliases <- c("pu","perceived usefulness","performance
expectancy","relative advantage",
               "perceived value","perceived functional benefit","pfb")
ifelse(x0 %in% aliases, "PU", x0)
}
to_bi <- function(x) {
  x0 <- tolower(trimws(ifelse(is.na(x), "", as.character(x))))
  bi  <- c("bi","behavioral intention","intention to use","intention")
ifelse(x0 %in% bi, "BI", x0)
}
to_peou <- function(x) {
  x0 <- tolower(trimws(ifelse(is.na(x), "", as.character(x))))   aliases <-
c("peou","perceived ease of use","effort expectancy","ease of use")
  ifelse(x0 %in% aliases, "PEOU", x0)
}
to_quality <- function(x) {
  x0 <- tolower(trimws(ifelse(is.na(x), "", as.character(x))))   aliases
<- c("quality","system quality","service quality","information quality",
               "is quality","e-service quality","website quality","portal
quality")
  ifelse(x0 %in% aliases, "Quality", x0)
}
to_satisfaction <- function(x) {
  x0 <- tolower(trimws(ifelse(is.na(x), "", as.character(x))))
aliases <- c("satisfaction","user satisfaction","customer
satisfaction","citizen satisfaction")   ifelse(x0 %in%
aliases, "Satisfaction", x0)
}
make_slab <- function(df) {
  ay  <- ifelse("Authors_Year" %in% names(df) & !is.na(df$Authors_Year),
df$Authors_Year, "")
  sid <- ifelse("Study_ID" %in% names(df) & !is.na(df$Study_ID),
paste0("[", df$Study_ID, "]"), "")   trimws(paste0(ay, " ",
sid))
}
# Core pipeline: read ,Üí harmonize ,Üí rebuild SE/CI ,Üí filter ,Üí meta
,Üí save
run_one_path <- function(file_path, outdir,
                         iv_mapper, dv_mapper, iv_name, dv_name,
xlab_text,
```

```
                        within_study_average_qualities = FALSE) {

  if (!file.exists(file_path)) stop("File not found: ", file_path)
dir.create(outdir, showWarnings = FALSE, recursive = TRUE)

  # Load first sheet safely
  sheet_use <- tryCatch(excel_sheets(file_path)[1], error = function(e) 1)
raw <- tryCatch(read_excel(file_path, sheet = sheet_use),
error = function(e) stop("Cannot read Excel: ", e$message))

  # Normalize column names
  names(raw) <- make.names(names(raw))

  # Ensure expected columns are present
need_cols <-
c("Study_ID","Authors_Year","Title","Journal","Country","Population","N",
"Domain","Method","Model","IV","DV","Path","Beta","SE","t_value","p_value"
,

"CI_lower","CI_upper","R2","Moderators","Quality","Notes")
for (c in need_cols) if (!c %in% names(raw)) raw[[c]] <- NA

  # Coerce numerics / clean p
raw <- raw %>%
    coerce_if_present("Beta") %>%
coerce_if_present("SE") %>%
coerce_if_present("t_value") %>%
coerce_if_present("CI_lower") %>%
coerce_if_present("CI_upper") %>%
coerce_if_present("N")
  if ("p_value" %in% names(raw)) raw$p_value <- parse_p(raw$p_value)

  # Harmonize constructs
raw$IV_clean <- iv_mapper(raw$IV)
raw$DV_clean <- dv_mapper(raw$DV)
  raw$Path_clean <- gsub("\\s", "", tolower(ifelse(is.na(raw$Path),"",
raw$Path)))

  # Rebuild SE/CI if needed
dat <- raw %>%     mutate(
      SE_calc = dplyr::case_when(
        !is.na(SE) ~ SE,
        !is.na(Beta) & !is.na(t_value) & t_value != 0 ~ abs(Beta /
t_value),
        is.na(SE) & is.na(t_value) & !is.na(CI_lower) & !is.na(CI_upper) ~
(CI_upper - CI_lower) / (2*1.96),
        (!is.na(p_value) & !is.na(Beta)) ~ abs(Beta / qnorm(1 -
p_value/2)),  # z approx
        TRUE ~ NA_real_
      ),
```

```
      t_calc =
dplyr::case_when(         !is.na(t_value) ~
t_value,
        !is.na(SE_calc) & !is.na(Beta) & SE_calc > 0 ~ Beta / SE_calc,
        TRUE ~ NA_real_
      ),
      CI_lower = ifelse(is.na(CI_lower) & !is.na(Beta) & !is.na(SE_calc),
Beta - 1.96*SE_calc, CI_lower),
      CI_upper = ifelse(is.na(CI_upper) & !is.na(Beta) & !is.na(SE_calc),
Beta + 1.96*SE_calc, CI_upper)
    )

  # Candidate rows (right constructs)
  candidates <- dat %>% filter(IV_clean == iv_name, DV_clean == dv_name)

  # Optionally average multiple ,Äúquality types,Äù within study
(Quality,ÜíSatisfaction case)
  if (within_study_average_qualities) {
    # Inverse-variance weighted mean per Study_ID
    meta_df <- candidates %>%
      mutate(yi = Beta, vi = SE_calc^2) %>%
      filter(!is.na(yi), is.finite(yi), !is.na(vi), is.finite(vi), vi > 0)
%>%
      group_by(Study_ID) %>%
      summarise(
        Authors_Year = first(Authors_Year),
        Title        = first(Title),
        Journal      = first(Journal),
        Country      = first(Country),
        Population   = first(Population),
        N            = suppressWarnings(as.numeric(first(N))),
        Domain       = first(Domain),
        Method       = first(Method),
        Model        = first(Model),
        # meta-analytic fixed-effect within a study (k small; just combine
correlated indicators)
        yi = sum(yi/vi) / sum(1/vi),
vi = 1 / sum(1/vi),         SE_calc =
sqrt(vi),         t_calc  = yi /
SE_calc,         CI_lower = yi -
1.96*SE_calc,
        CI_upper = yi + 1.96*SE_calc,
        R2 = suppressWarnings(as.numeric(first(R2))),
        Moderators = first(Moderators),
        Quality    = first(Quality),
        Notes      = "Within-study IVW average of multiple
Quality,ÜíSatisfaction paths"
      ) %>%
ungroup()   }
else {
    meta_df <- candidates %>%
```

```
      mutate(yi = Beta, vi = SE_calc^2) %>%
      filter(!is.na(yi), is.finite(yi), !is.na(vi), is.finite(vi), vi > 0)
  }

  # Save eligibility audit (why some rows are not pooled)
elig_snapshot <- candidates %>%     mutate(
      has_beta = !is.na(Beta),
has_se   = !is.na(SE_calc),
reason   =
dplyr::case_when(         !has_beta ~
"Missing Beta",
        has_beta & !has_se ~ "No SE derivable (need SE or t or CI or
numeric p)",
        TRUE ~ NA_character_
      )
) %>%
    select(Study_ID, Authors_Year, IV, DV, Beta, SE, t_value, p_value,
CI_lower, CI_upper, SE_calc, reason)

  write.csv(elig_snapshot, file.path(outdir,"eligibility_log.csv"),
row.names = FALSE)

  if (nrow(meta_df) == 0) {
    cat("\n[", iv_name, ",Üí", dv_name, "] No eligible rows with both Beta
and derivable SE.\n",
        "See: ", normalizePath(file.path(outdir,"eligibility_log.csv")),
"\n", sep = "")
    return(invisible(NULL))
  }

  # Fit meta (k-aware)
k <- nrow(meta_df)
  res.re <- res.fe <- pred <- NULL
     if (k >=
3) {
    res.re <- rma.uni(yi = yi, vi = vi, data = meta_df, method = "REML")
res.fe <- rma.uni(yi = yi, vi = vi, data = meta_df, method = "FE")
pred   <- predict(res.re)   } else if (k == 2) {
    res.fe <- rma.uni(yi = yi, vi = vi, data = meta_df, method = "FE")
  } # k==1 handled downstream

  # Save included rows and characteristics (clean table)
incl_tbl <- meta_df %>%
    transmute(
      Study_ID, Authors_Year, Title, Journal, Country, Population, N,
Domain, Method, Model,
      Beta = yi,
SE_calc = sqrt(vi),
      t_calc  = ifelse(is.na(vi) | vi <= 0, NA_real_, yi / sqrt(vi)),
      CI_lower, CI_upper, R2, Moderators, Quality, Notes
    )
```

```
  write.csv(incl_tbl, file.path(outdir, "included_rows.csv"), row.names =
FALSE)

  # Study characteristics (minimal)
char_tbl <- meta_df %>%
    transmute(
      Study_ID, Authors_Year, Country, Population, N, Method, Model
    )
  write.csv(char_tbl, file.path(outdir, "study_characteristics.csv"),
row.names = FALSE)
     #
Plots
  if (k >= 3 && !is.null(res.re)) {
    png(file.path(outdir,"forest.png"), width=3000, height=2200, res=300)
forest(res.re, slab = make_slab(meta_df),
           xlab = paste0("Standardized path coefficient (", iv_name, " ,Üí
", dv_name, ")"),
           mlab = "REML model", cex = 0.9)
dev.off()
    png(file.path(outdir,"funnel.png"), width=2400, height=1800, res=300)
funnel(res.re, xlab = paste0("Standardized path coefficient (", iv_name,
" ,Üí ", dv_name, ")"))     dev.off()

    tf <- tryCatch(trimfill(res.re), error=function(e) NULL)
if (!is.null(tf)) {
      png(file.path(outdir,"funnel_trimfill.png"), width=2400,
height=1800, res=300)
      funnel(tf, xlab = paste0("Standardized path coefficient (", iv_name,
" ,Üí ", dv_name, ") ,Äî Trim & Fill"))
dev.off()
    }
    inf <- influence(res.re)
    png(file.path(outdir,"influence.png"), width=3000, height=2200,
res=300)     plot(inf)     dev.off()
    write.csv(as.data.frame(leave1out(res.re)),
file.path(outdir,"leave1out.csv"), row.names = FALSE)

  } else if (k == 2 && !is.null(res.fe)) {
    png(file.path(outdir,"forest.png"), width=3000, height=2200, res=300)
forest(res.fe, slab = make_slab(meta_df),
           xlab = paste0("Standardized path coefficient (", iv_name, " ,Üí
", dv_name, ")"),
           mlab = "FE model (k=2)", cex = 0.9)
dev.off()

  } else if (k == 1) {
    # Just compute and print CI for single study (no pooling)
b  <- meta_df$yi[1]; se <- sqrt(meta_df$vi[1])     ci.lb <- b
- 1.96*se; ci.ub <- b + 1.96*se
    cat(sprintf("\n[%s ,Üí %s] (k=1) Single study: Œ≤=%.3f, 95%% CI [%.3f,
%.3f]\n",
```

```
                iv_name, dv_name, b, ci.lb, ci.ub))
  }

  # Print reporting cheat-sheet
  cat("\n=== REPORTING CHEAT-SHEET: ", iv_name, " ,Üí ", dv_name, "
===\n", sep = "")   if
(!is.null(res.re)) {
    cat(sprintf("Random effects (REML): Œ≤ = %.3f (95%% CI %.3f,Äì%.3f),
p%s\n",
                as.numeric(res.re$b),   res.re$ci.lb,   res.re$ci.ub,
ifelse(res.re$pval < .001, "<.001", sprintf("=%.3f", res.re$pval))))
    cat(sprintf("Heterogeneity: Q(%.0f)=%.2f, p%s; I^2=%.1f%%;
tau^2=%.4f\n",
                res.re$k-1, res.re$QE,
                ifelse(res.re$QEp < .001, "<.001", sprintf("=%.3f",
res.re$QEp)),
                res.re$I2, res.re$tau2))
    if (!is.null(pred)) cat(sprintf("Prediction interval: [%.3f, %.3f]\n",
pred$pi.lb, pred$pi.ub))   } else if (!is.null(res.fe)) {
    cat(sprintf("Fixed effects: Œ≤ = %.3f (95%% CI %.3f,Äì%.3f), p%s\n",
as.numeric(res.fe$b),            res.fe$ci.lb,            res.fe$ci.ub,
ifelse(res.fe$pval < .001, "<.001", sprintf("=%.3f", res.fe$pval))))   }
else {
    cat("No pooled model (k < 2).\n")
  }
  cat("Files saved to: ", normalizePath(outdir), "\n", sep = "")
invisible(list(included = incl_tbl, characteristics = char_tbl)) }

## ------------------------------------------------------------
## 2) Run the three meta-analyses
## ------------------------------------------------------------

## (A) PU ,Üí BI res_pu_bi <-
run_one_path(   file_path =
file_path_pu_bi,   outdir    =
outdir_pu_bi,   iv_mapper = to_pu,
dv_mapper = to_bi,   iv_name   = "PU",
dv_name   = "BI",
  xlab_text = "Standardized path coefficient (PU ,Üí BI)",
within_study_average_qualities = FALSE
)

## (B) PEOU ,Üí PU res_peou_pu <-
run_one_path(   file_path =
file_path_peou_pu,   outdir    =
outdir_peou_pu,   iv_mapper = to_peou,
dv_mapper = to_pu,   iv_name   = "PEOU",
dv_name   = "PU",
  xlab_text = "Standardized path coefficient (PEOU ,Üí PU)",
within_study_average_qualities = FALSE
)
```

```
## (C) Quality ,Üí Satisfaction
## If a study reports multiple ,Äúquality,Äù flavors
(System/Info/Service),
## we combine them within study via inverse-variance weighted average
## so that each study contributes once to the meta-analysis.
res_q_s <- run_one_path(   file_path = file_path_q_s,
outdir    = outdir_q_s,
  iv_mapper = to_quality, dv_mapper = to_satisfaction,
iv_name   = "Quality",  dv_name   = "Satisfaction",
  xlab_text = "Standardized path coefficient (Quality ,Üí Satisfaction)",
within_study_average_qualities = TRUE
)  cat("\n=== Done. See the three output folders for figures and
CSVs. ===\n")
```

SUPPLEMENTARY FIGURES DESCRIPTIONS

Supplementary Figures S1-S3: Funnel Plots

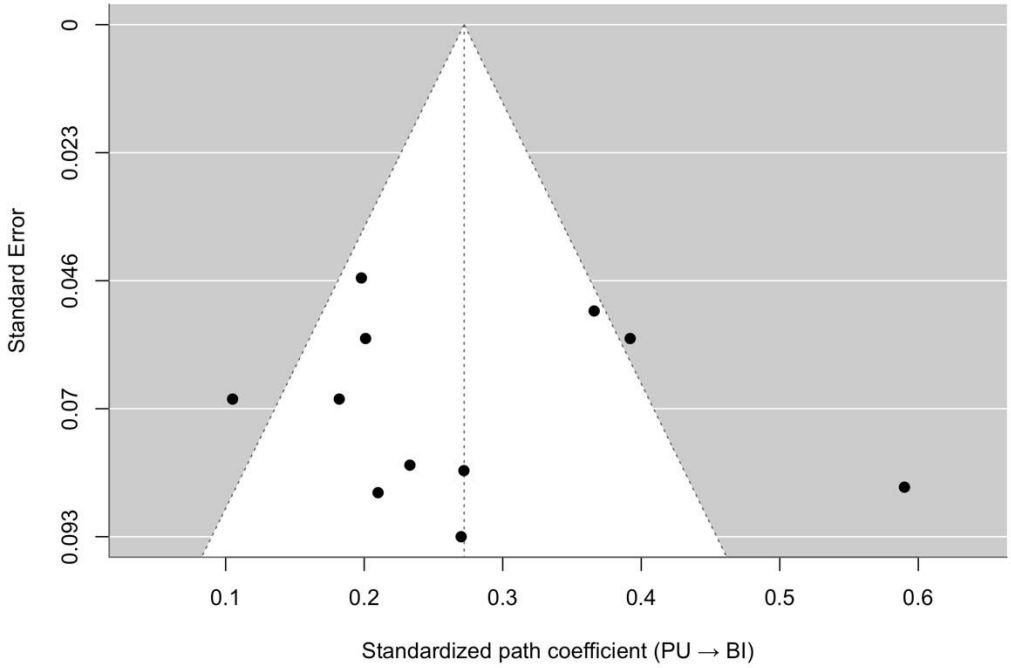


Figure S1: Funnel plot for PU→BI: *Effect sizes plotted against standard errors, showing broadly symmetrical distribution around the pooled estimate (β = 0.272). Egger's test showed no significant asymmetry (z = 0.417, p = 0.677).*

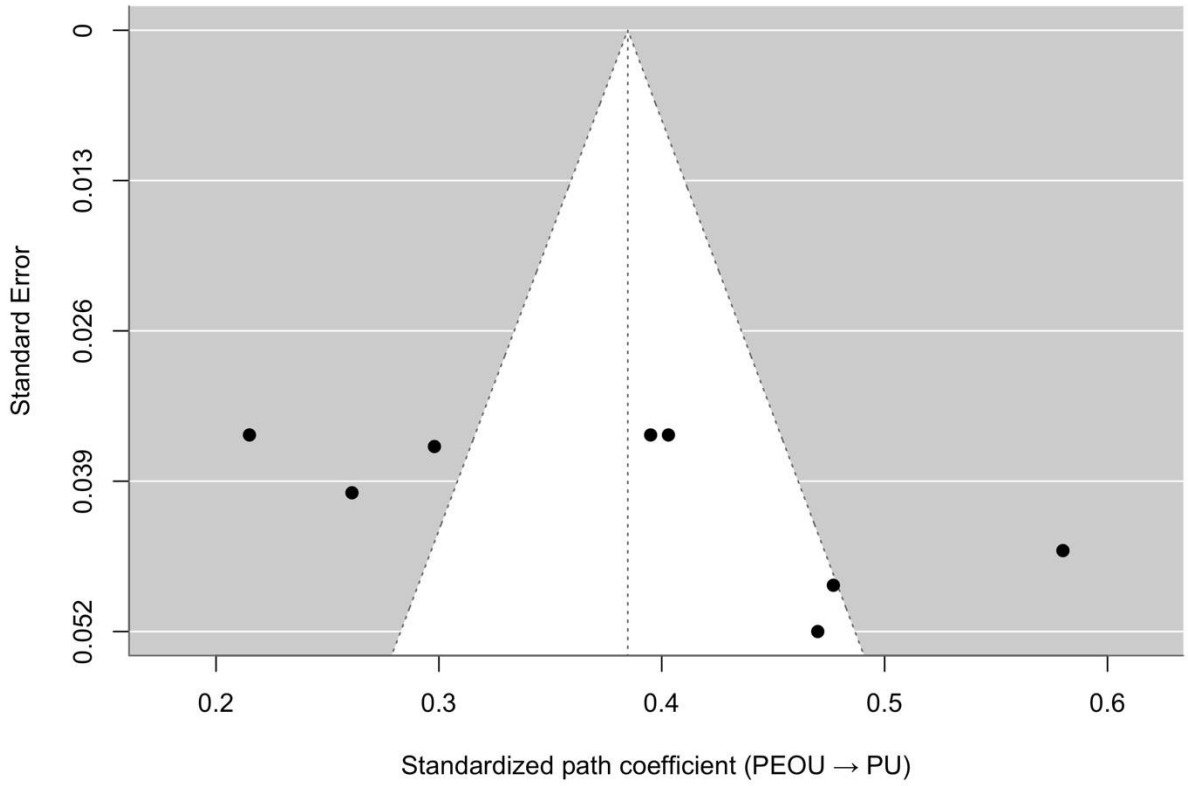


Figure S2: Funnel plot for PEOU→PU: *Effect sizes plotted against standard errors, with four studies on each side of the pooled estimate (β = 0.385). Egger's test showed significant asymmetry (z = 2.06, p = 0.040), suggesting potential small-study effects.*

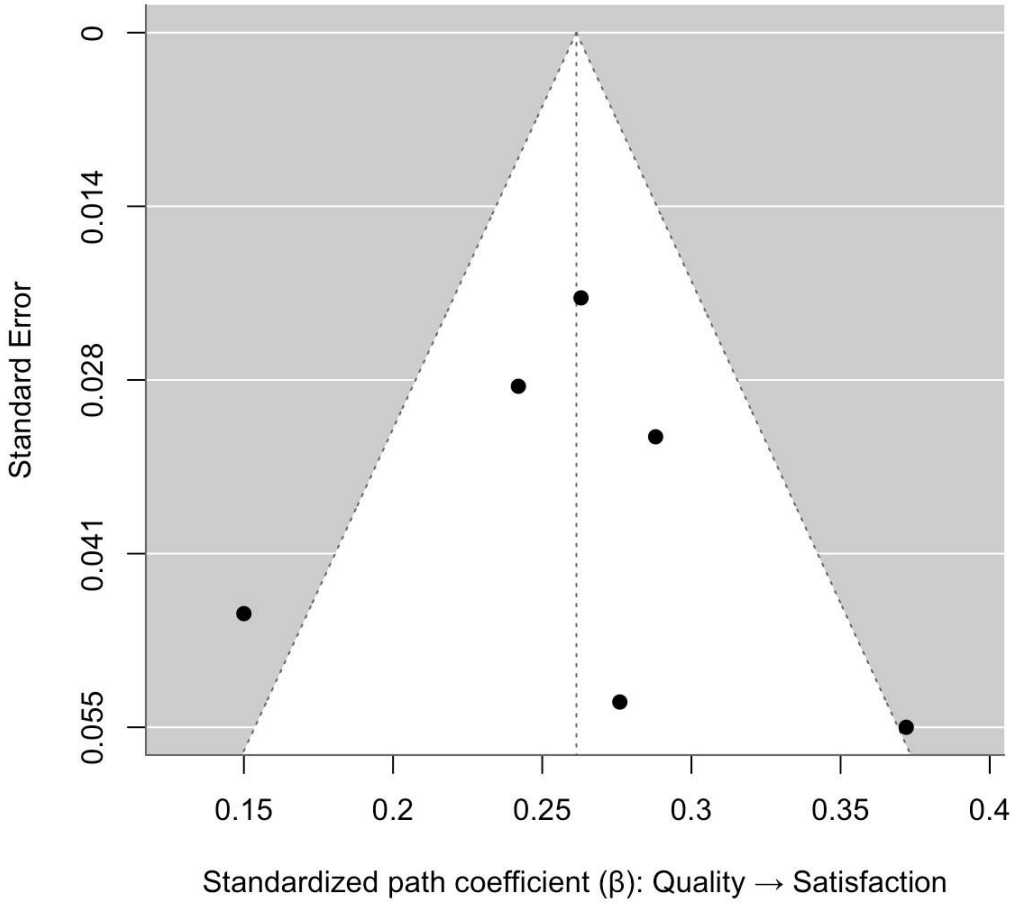


Figure S3: Funnel plot for Quality→Satisfaction: *Effect sizes plotted against standard errors, with three studies on each side of the pooled estimate (vertical dashed line at β = 0.261). Egger's test showed no significant asymmetry (z = 0.39, p = 0.696).*

- **Supplementary Figures S4-S6: Trim-and-Fill Plots**

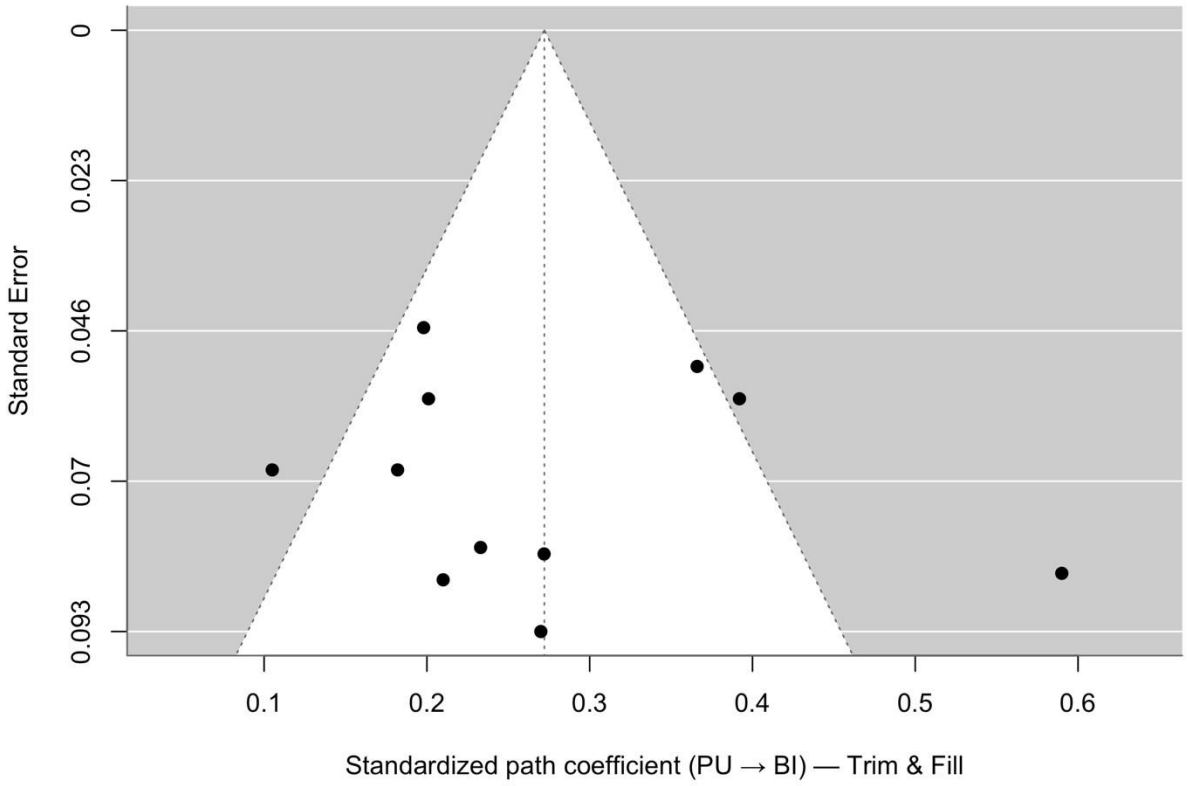


Figure S4: Trim-and-fill for PU→BI (0 studies imputed): shows the trim-and-fill adjusted funnel plot. The trim-and-fill procedure identified no asymmetry requiring correction and consequently imputed zero additional studies. All eleven points shown in **Figure 3** represent the original observed studies (filled circles), with no open circles indicating imputed studies. The trim-andfill adjusted pooled estimate remained identical to the original estimate (β = 0.272, 95% CI [0.197, 0.348]), providing strong evidence that publication bias, if present, does not meaningfully affect the observed association between perceived usefulness and behavioral intention.

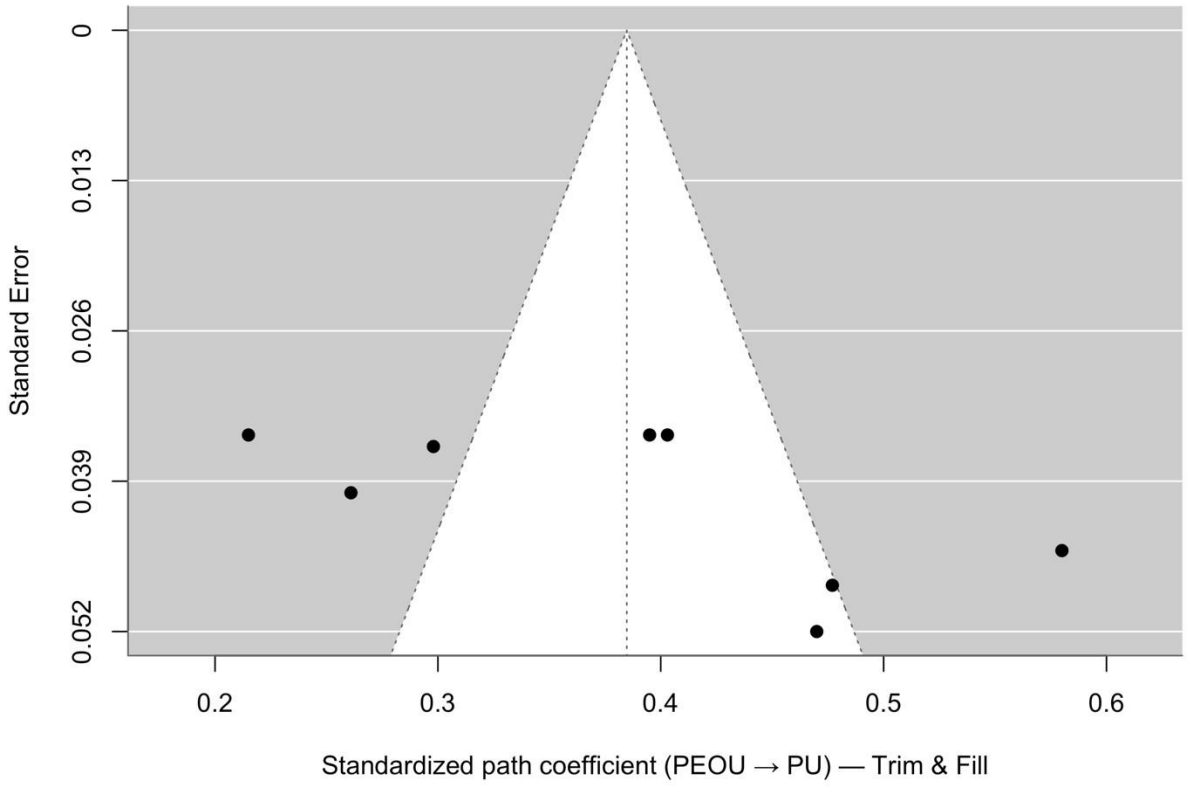


Figure S5: Trim-and-fill for PEOU→PU (0 studies imputed): shows the trim-and-fill adjusted funnel plot. Despite the significant Egger's test result, the trim-and-fill procedure identified no asymmetry requiring correction and consequently imputed zero additional studies ($k_0 = 0$). All eight points shown in **Figure 3** represent the original observed studies (filled circles), with no open circles indicating imputed studies. The trim-and-fill adjusted pooled estimate remained identical to the original estimate ($\beta = 0.385$, 95% CI [0.300, 0.470]), with the 95% prediction interval also unchanged ([0.143, 0.627]).

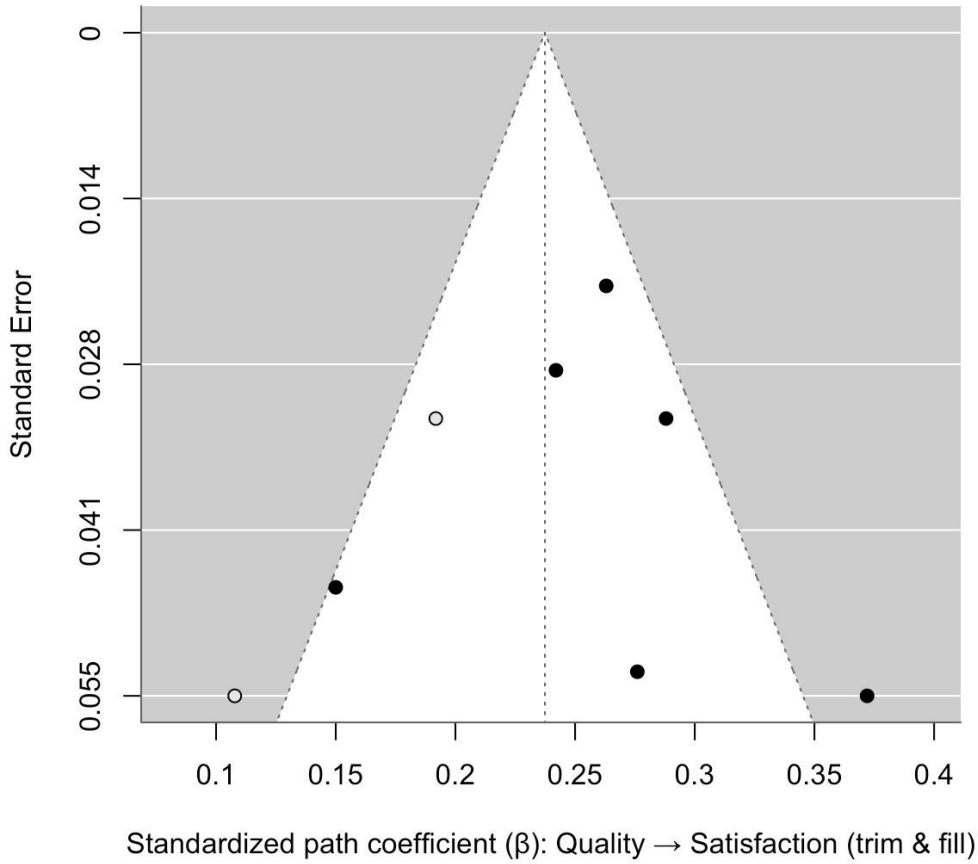


Figure S6: Trim-and-fill for Quality→Satisfaction (2 studies imputed): *Original six studies (filled circles) and two imputed studies (open circles) added to restore symmetry. The adjusted pooled estimate remained essentially unchanged, supporting robustness against publication bias.*

Supplementary Figures S7-S9: Eight-Panel Influence Diagnostics

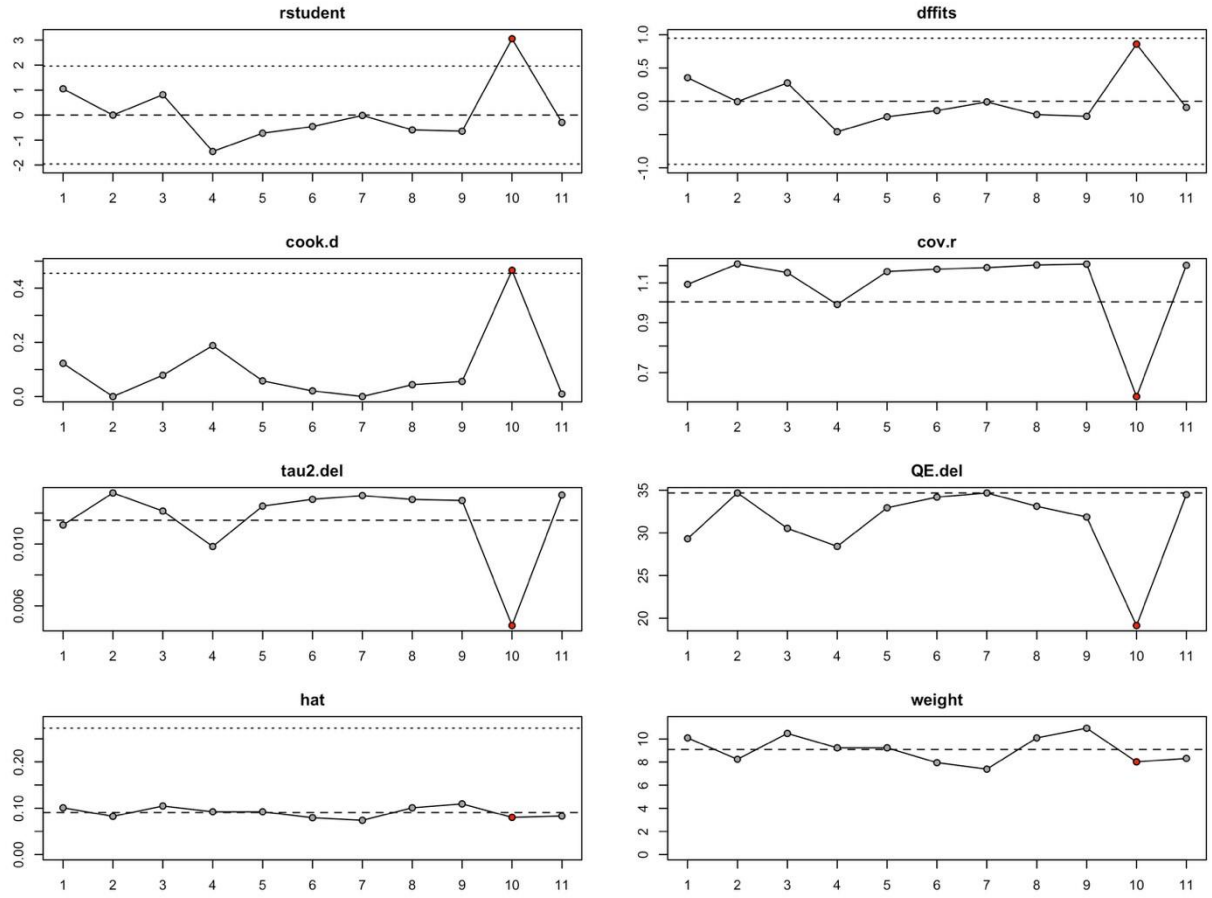


Figure S7: Influence diagnostics for PU→BI: presents eight diagnostic plots examining study influence across multiple metrics. The top-left panel shows externally studentized residuals (rstudent), with most values clustering between -1 and +2. Study 10 (Althunibat et al., 2021) shows a large positive residual at approximately +2.5, indicating its effect size is substantially larger than predicted by the model. Study 4 (Aboagye-Darko & Mkhize, 2025) shows a notable negative residual at approximately -3.0, the largest deviation observed across all studies. This value exceeds the typical ±2 threshold, indicating that this study's effect size is considerably smaller than expected. Despite this deviation, the residual remains within the more conservative ±3 threshold often used for identifying extreme outliers.

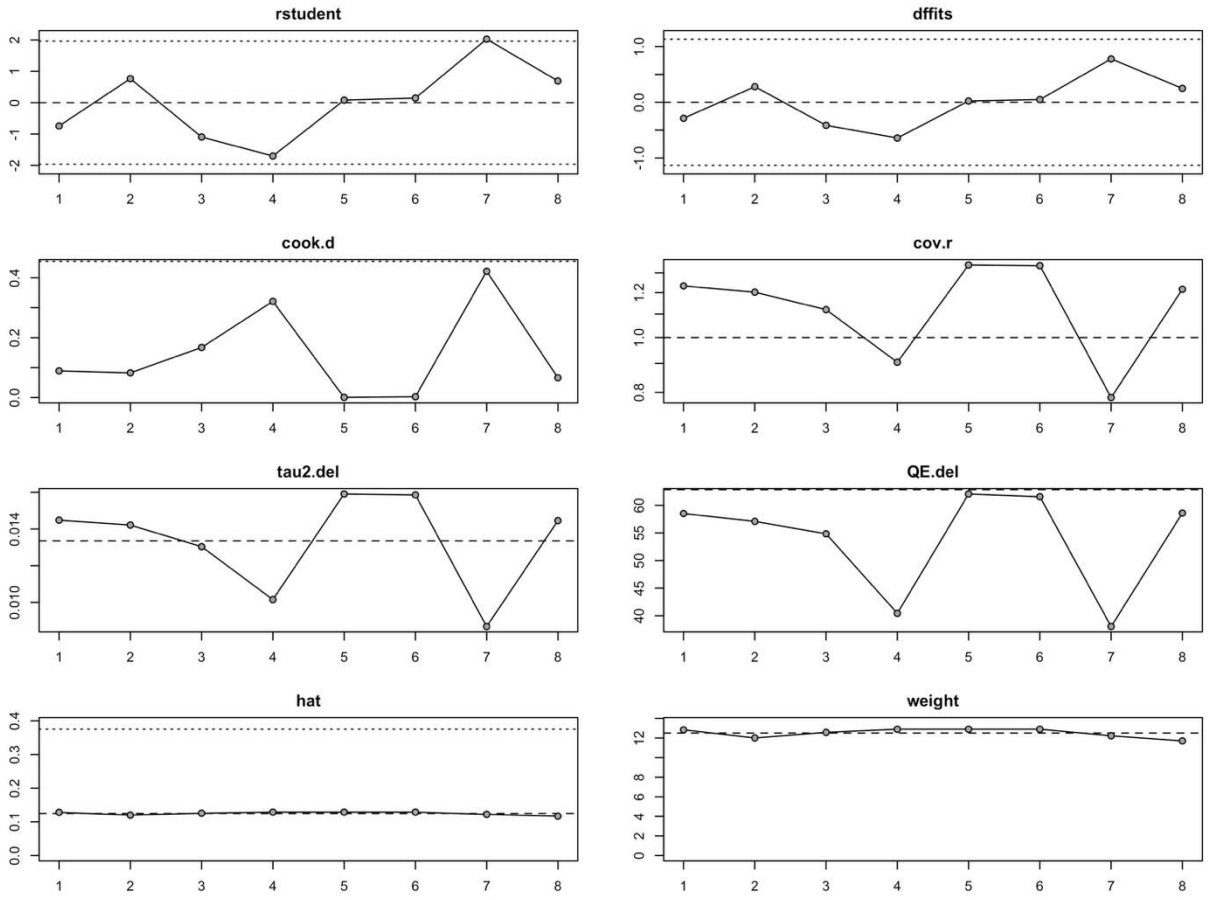


Figure S8: Influence diagnostics for PEOU→PU: presents eight diagnostic plots examining study influence across multiple metrics. The top-left panel shows externally studentized residuals (rstudent), with values ranging from approximately -2.5 to +2.5. Study 7 (Alenezi et al., 2023) shows the largest positive residual at approximately +2.3, indicating its effect size (β = 0.580) is substantially larger than predicted by the model. Study 4 (Hasan et al., 2024) shows a notable negative residual at approximately -2.2, reflecting that its effect size (β = 0.215) is considerably smaller than expected. Study 3 (Rehman et al., 2023) also shows a negative residual at approximately -1.5. Most other studies show residuals within ±1.5, with all values remaining within the ±2.5 range typically considered acceptable.

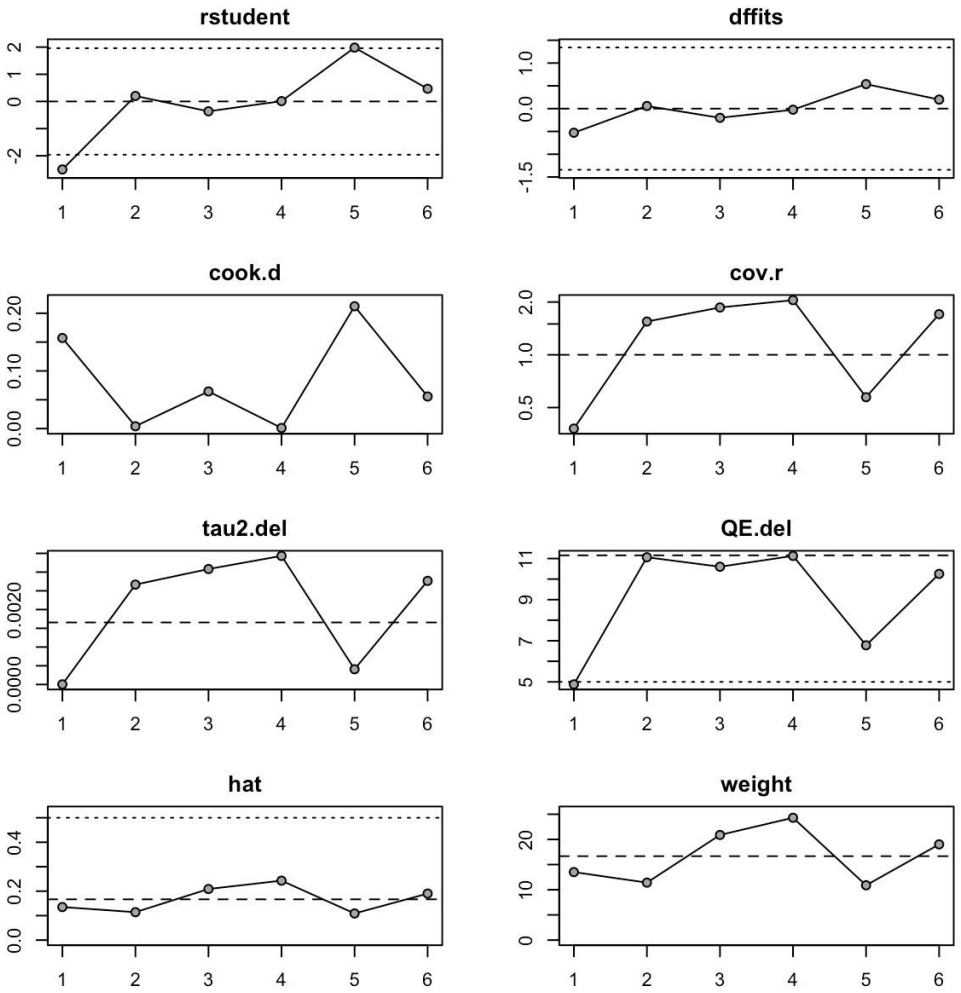


Figure S9: Influence diagnostics for Quality→Satisfaction: presents eight diagnostic plots examining study influence. The top-left panel shows externally studentized residuals (rstudent), with values ranging from approximately -2.5 to +2.0. Study 5 (Nookhao & Kiattisin, 2023) shows the largest positive residual at approximately +2.0, while Study 1 (Rehman et al., 2023) shows the largest negative residual at approximately -2.2. All residuals fall within the typical threshold of ±2.5 standard deviations.