User Manuel on the tool "Extended MASEM Analysis from SO, YANG AND LI (2025)"

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Based on: So, K. K. F., Yang, Y., & Li, X. (2025). Fifteen years of research on customer loyalty formation: A meta-analytic structural equation model. *Cornell Hospitality Quarterly*, *66*(2), 253-272.

1. Introduction & Purpose

This web-based application is designed to conduct Meta-Analytic Structural Equation Modeling (MASEM). It is built upon the foundational research of So, Yang, and Li (2025), which synthesized 15 years of research to determine the interrelationships between Customer Loyalty, Customer Satisfaction, Perceived Value, and Perceived Service Quality.

Key Features:

- Replication: Users can replicate the findings of So, Yang, and Li (2025) using pre-loaded, industry-specific data.

- Extension: The tool allows researchers to expand the original model by adding new variables (e.g., *Place Attachment*, *Trust*, *Brand Image*) to test novel theoretical frameworks.

- Methodology: It utilizes the Harmonic Mean or Minimal N methods to aggregate sample sizes.

2. Pre-loaded Data Sets

To facilitate immediate analysis, the tool comes pre-loaded with the correlation matrices () and pairwise sample sizes () derived from the meta-analysis of 153 articles.

The four base variables are fixed:

1. Loyalty (Customer Loyalty)

2. Satisfaction (Customer Satisfaction)

3. Value (Perceived Value)

4. Quality (Perceived Service Quality)

You can select from four specific sample contexts:

- All: Aggregated data from all sectors (Total N ≈ 87,286).

- Lodging: Specific to the hotel and accommodation industry.

- Restaurant: Specific to the food and beverage industry.

- Tourism and Travel: Specific to general tourism contexts.

Note: The tool automatically loads the correct lower-triangle correlation matrix and sample sizes for the selected sample.

3. Step-by-Step Usage Guide
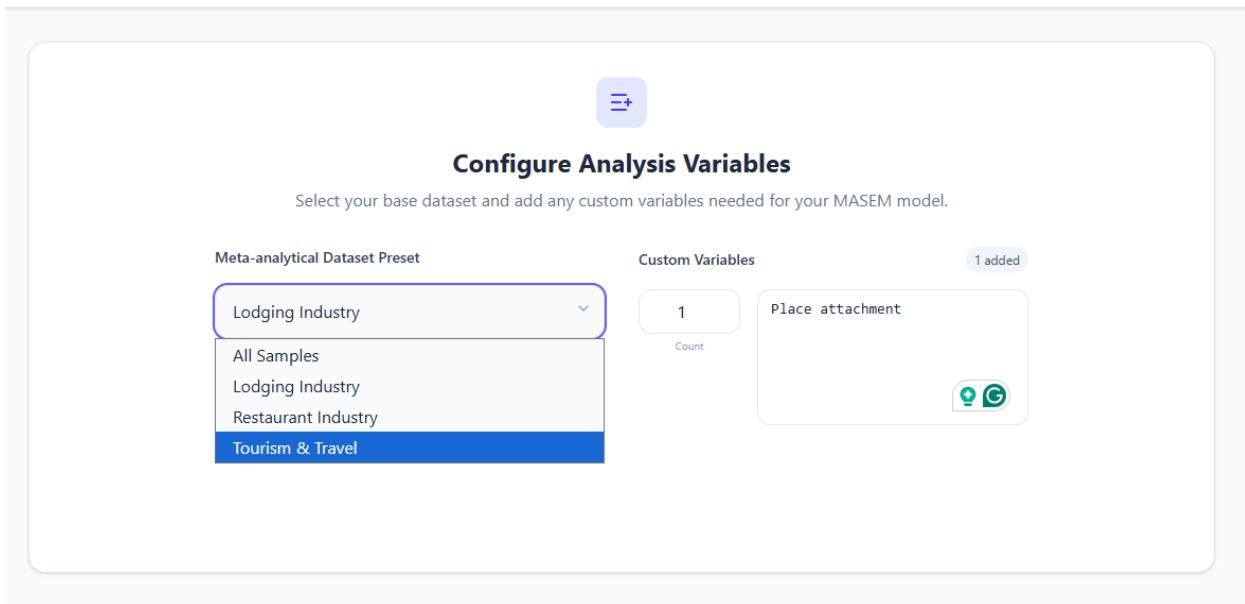
Step 1: Configuration

1. Select Sample: Use the dropdown menu at the top to choose your data context (e.g., Lodging or Restaurant). The base matrix will automatically update.

Step 1a: Adding New Variables (Optional)

You can extend the model by adding up to 3 new variables (e.g., *Place Attachment*).

1. Data Requirement: Before adding a variable, you must have performed a meta-analysis to obtain:

   o The correlation coefficients () between your new variable and the four base variables (Loyalty, Satisfaction, Value, Quality).

   o The corresponding sample sizes () for these relationships.

2. Input:

   o In the Variables panel, enter the number of new variables (e.g., 1).

   o Type the name of the new variable (e.g., Place Attachment) in the text box.

   o Click "Apply variables".

3. The Matrix table will expand to include rows and columns for your new variable.

Step 2: Matrix Data Entry

1. Locate Empty Cells: If you added a new variable, its corresponding cells in the matrix (intersection with base variables) will be empty.

2. Enter Data:

   o Grid Mode (Recommended): Manually enter the (correlation) and (sample size) for the new relationships. The tool enforces symmetry automatically (editing row , col updates row , col).

   o Text Mode: You can paste a comma-separated (CSV) format matrix. Ensure the format follows r|n (e.g., 0.55|1200) for off-diagonal cells.

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1 Setup Variables — 2 Input Data — 3 Build Model — 4 Analysis Results
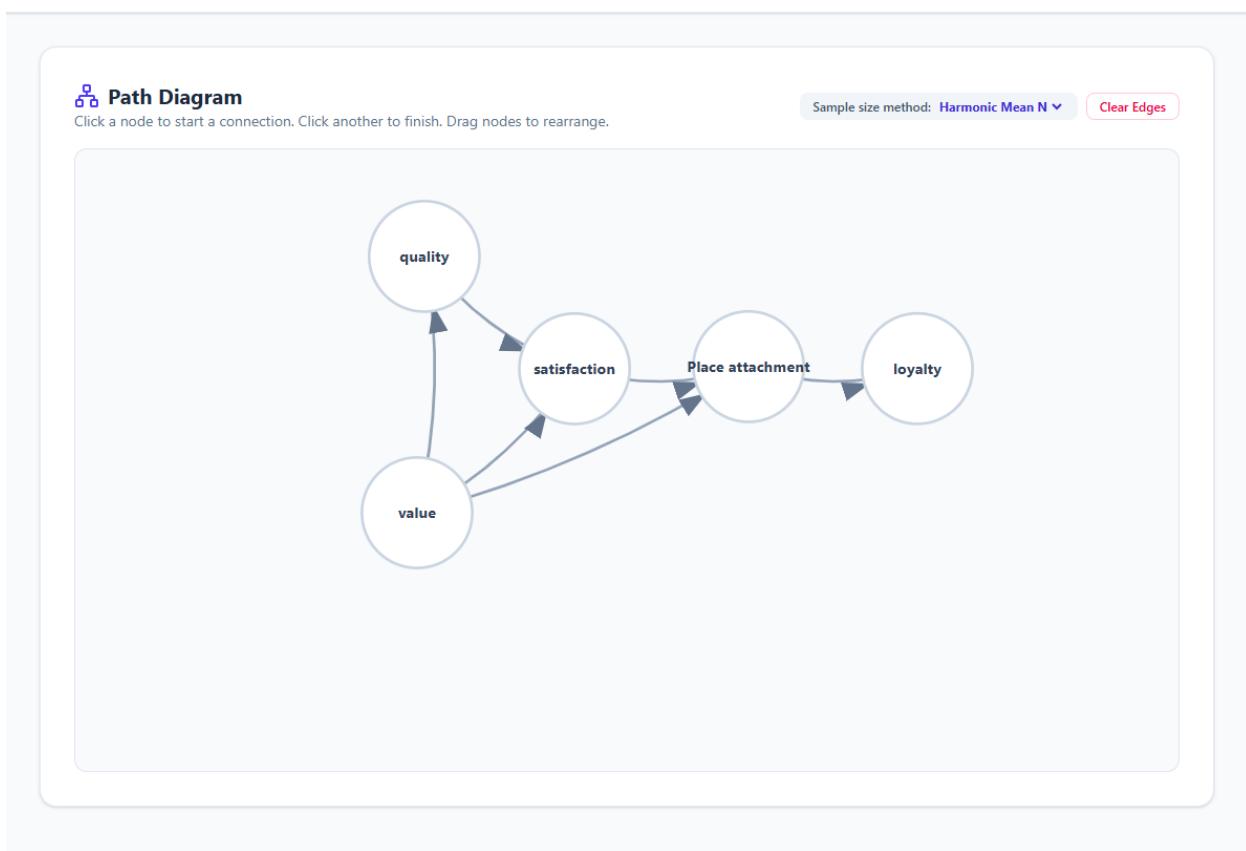
⊞ Correlation Matrix

Input Pearson's *r* and pairwise sample size *N* after meta analysis on correlation effect size.

Grid Input | Text Paste

Variables	loyalty	satisfaction	value	quality	Place attachment
loyalty	1.00	r 0.726 / N 19271	r 0.675 / N 11993	r 0.547 / N 12251	r 0.565 / N 8585
satisfaction	r 0.726 / N 19271	1.00	r 0.77 / N 12705	r 0.922 / N 8859	r 0.254 / N 6547
value	r 0.675 / N 11993	r 0.77 / N 12705	1.00	r 0.784 / N 9268	r 0.444 / N 5222
quality	r 0.547 / N 12251	r 0.922 / N 8859	r 0.784 / N 9268	1.00	r 0.02 / N -
Place attachment	r 0.565 / N 8585	r 0.254 / N 6547	r 0.444 / N 5222	r 0.02 / N -	1.00
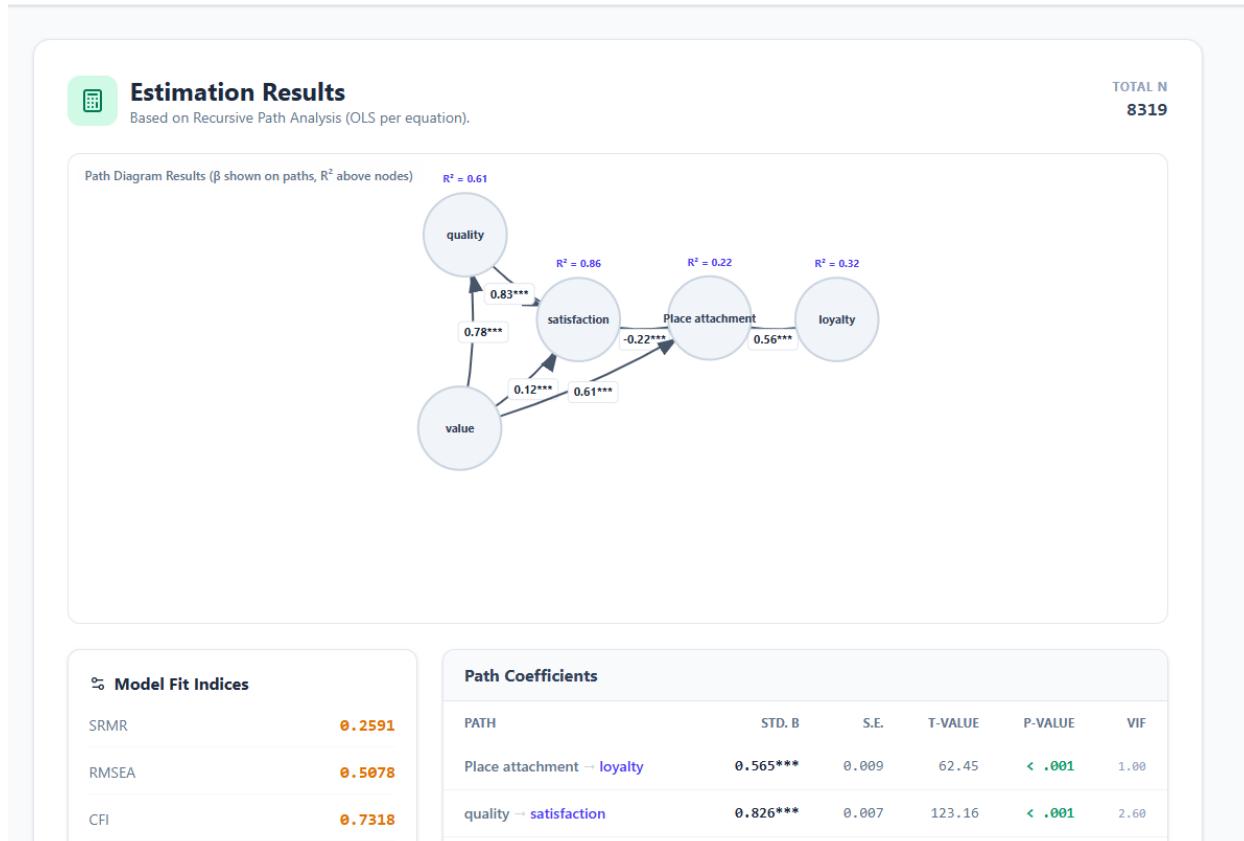
Step 3: Building the Path Model

1. Draw Paths: Use the Diagram panel to hypothesize your model.

   o Click the Source Node (e.g., *Quality*).

   o Click the Target Node (e.g., *Value*).

   o An arrow (path) will appear connecting them.

2. Customize: If you added *Place Attachment*, click it and connect it to other variables based on your hypothesis (e.g., *Place Attachment Loyalty*).

3. Select Sample size method: Choose Harmonic mean (recommended by So et al., 2025) or Minimum N to determine how the total sample size for the model is calculated from the pairwise values.

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Path Diagram
Click a node to start a connection. Click another to finish. Drag nodes to rearrange.

Sample size method: **Harmonic Mean N** ⌄   Clear Edges

Step 4: Estimation & Analysis

1. Click the "Run estimation" button.

2. View Results:

    o   Diagram: The arrows in the diagram will now display the estimated standardized path coefficients ().

    o   Estimation Panel: Scroll down to see detailed tables:

        ▪   Path Coefficients: The strength and direction of relationships.

        ▪   : The variance explained for endogenous variables.

        ▪   Goodness of Fit: Check indices like SRMR, CFI, and RMSEA.

            ▪   *Note:* A "Perfect fit" (CFI=1.00) usually indicates a saturated model (all possible paths connected).

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Estimation Results

Based on Recursive Path Analysis (OLS per equation).

TOTAL N
8319

Path Diagram Results (β shown on paths, R² above nodes)

Model Fit Indices	
SRMR	**0.2591**
RMSEA	**0.5078**
CFI	**0.7318**

Path Coefficients

PATH	STD. B	S.E.	T-VALUE	P-VALUE	VIF
Place attachment → loyalty	0.565***	0.009	62.45	< .001	1.00
quality → satisfaction	0.826***	0.007	123.16	< .001	2.60

4. Troubleshooting & Error Codes

If the estimation fails, the tool will display error messages in the red box. Common issues include:

- **"Correlation matrix row count does not match header size":**
  - *Cause:* You added a new variable name but didn't click "Apply variables," or the pasted text matrix doesn't match the number of active variables.
  - *Fix:* Ensure the number of variables in the "Variables" panel matches the data in the matrix.

- **"Matrix is singular (cannot invert)":**
  - *Cause:* Extreme multicollinearity (two variables are too highly correlated, e.g.,), making them mathematically indistinguishable.
  - *Fix:* Check your input correlations. If two variables correlate near 1.0, consider merging them or removing one.

- **"Observed/implied matrix not positive definite":**

- *Cause:* The correlation matrix is mathematically invalid (often happens with pairwise deletion or inconsistent meta-analytic data sources).

- *Fix:* Check for logical inconsistencies (e.g., A correlates strongly with B, B with C, but A and C have a contradictory correlation).

- **"Total N is invalid":**

  - *Cause:* One or more cells in the matrix have a value of 0, 1, 2, or missing.

  - *Fix:* Ensure every off-diagonal cell has a valid sample size ().

- **"df = 0":**

  - *Cause:* The model is saturated (degrees of freedom = 0). This happens if you draw arrows between *every* pair of variables.

  - *Result:* Fit indices (RMSEA, CFI, TLI) cannot be computed meaningfully, though path coefficients are valid. Remove non-significant paths to improve model parsimony.