UNIVERSITI TEKNOLOGI MARA

Cawangan Negeri Sembilan
Kampus Seremban

BULETIN FAKULTI PERAKAUNAN

Edisi 6

Partial Least Square-Structural Equation Equation Modelling (PLS-SEM) – Technique

by Salwa Muda, Musliha Musman, Amariah Hanum Binti Hussin and Raziah Bi Mohamed Sadique

What is PLS-SEM?

Herman Wold originally developed partial least square-structural equation modeling (PLS-SEM) in the 1970s with the aim of maximizing the explained variance of the dependent variables. PLS-SEM is similar to using multiple regression analysis in predicting causal relationships between exogenous and endogenous variables and has become a standard approach for analyzing complex inter-relationships between observed and latent variables. The statistical objective of PLS-SEM is to maximize the explained variance of the dependent variables, known as endogenous variables. As a second-generation technique of multivariate data analysis, the applications have grown in the past decade in the social sciences discipline and other fields such as agricultural science, engineering, environmental science, and medicine.

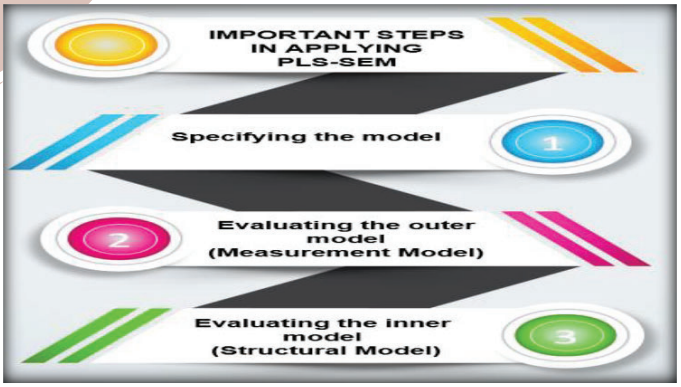
According to Hair et al. (2019), p.5, researchers should choose to use PLS-SEM under the following situations:

- When the analysis is concerned with testing a theoretical framework from a prediction perspective.
- When the structural model is complex and includes many constructs, indicators, and model relationships.
- When the research objective is to understand better increasing complexity by exploring theoretical extensions of established theories (exploratory research for theory development).
- When the path model includes one or more formatively measured constructs.
- When the research consists of financial ratios or similar types of data artifacts.
- When the research is based on secondary/archival data, which may lack a comprehensive substantiation on the grounds of measurement theory.
- When a small population restricts the sample size (e.g., business-to-business research); but PLS-SEM also works very well with large sample sizes.

- When distribution issues are a concern, such as a lack of normality; and
- When research requires latent variable scores for follow-up analyses.

What are the essential steps in applying PLS-SEM?

There are three essential steps in applying PLS-SEM: specifying the model, evaluating the outer model, and evaluating the inner model. SmartPLS, a graphical user interface software, analyzes the data. Figure 1 shows the path model in PLS-SEM.



1. **Specifying the model**

   In the stage of developing and specifying the model, it is essential for the researcher to identify the location of the constructs and the relationship between them, ensure there are no reverse relationships among the constructs, determine the application of multi-item or single-item scale for indicators and identify whether to use formative or reflective model for the latent variables (Hair et al.,2022). Independent variables, or exogenous variables, have path arrows pointing outwards and must not have arrows pointing at them. In contrast, dependent or endogenous variables must have at least one path arrow towards them.

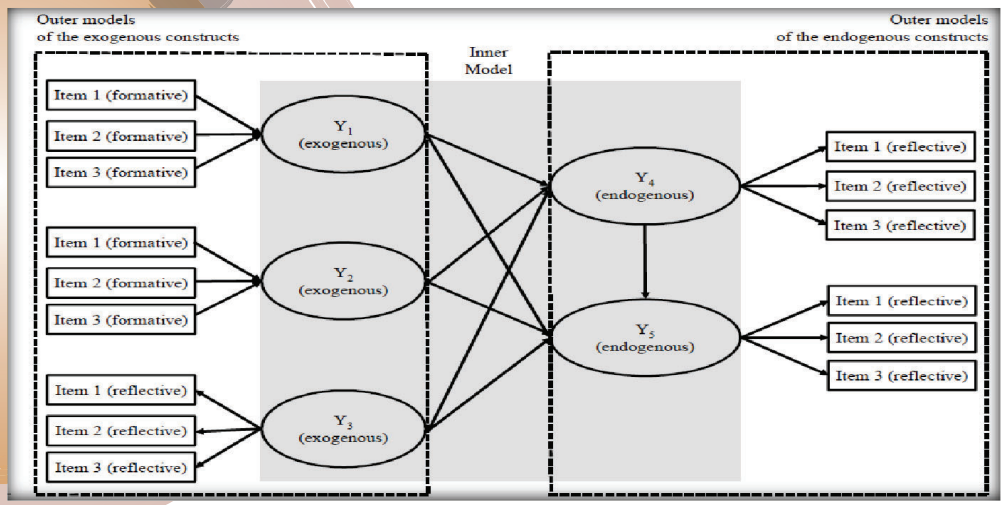


Figure 1 Path model in PLS-SEM

2. Evaluating the outer model (Measurement Model)

The outer model or measurement model evaluation aims to establish reliability and validity, providing an accurate basis for the inner model evaluation. The reliability test examines the consistency of the items in measuring the constructs. In contrast, the validity is conducted to examine how far a construct measures what it is supposed to measure. The reliability and validity tests that are conducted are internal consistency reliability, indicator reliability, convergent validity, and discriminant validity (Hair et al., 2022).

3. Evaluating the inner model (Structural Model)

The structural model's predictive capabilities and the relationships between the constructs are investigated to evaluate the model's validity. The evaluation comprises the procedures of examining the coefficients of determinations (R^2), predictive relevance (Q^2), size and significance of path coefficients, f^2 effect sizes, and q^2 effect sizes (Hair et al., 2022). Once the model has been thoroughly validated and the final model is confirmed, the hypotheses for the relationships between constructs can be confirmed or rejected, the research questions are answered, and the implications for the theory and practice are concluded. Figure 2 shows an example of the output of the structural model.

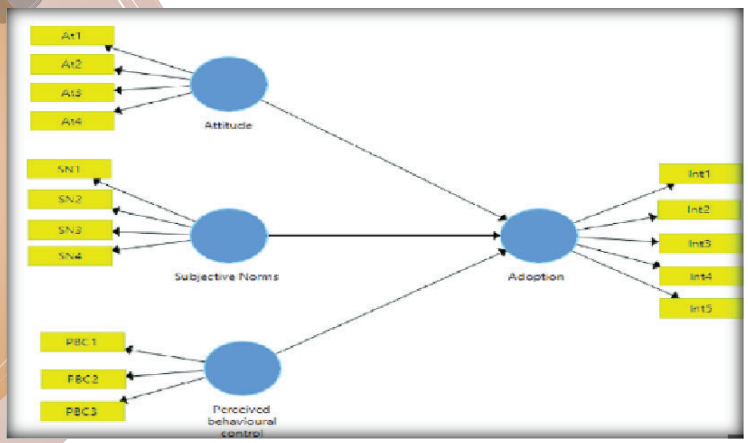


Figure 2: Structural Model

In summary, PLS-SEM has become a popular approach in analyzing hypothesized relationships and is frequently applied in broad areas of interest. Among the advantages of the PLS-SEM approach is that it enables the causal-relationship analysis to be conducted rigorously despite limited theoretical information, can handle complex model and modeling issues, and allows researchers to analyze data with non-normality distribution. Hence, in a landscape where research often demands flexibility and adaptability, PLS-SEM shines as an invaluable approach in many disciplines of studies.

Reference

Hair, J.F., Risher, J.J., Sarstedt, M. and Ringle, C.M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, 31 (1), pp. 2-24

Hair, J.F., Hult, G.T.M., Ringle, C.M. and Sarstedt, M. (2022), A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM), Sage, Thousand Oaks, CA