Structural Equation Modeling

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Objective of Presentation

- ✔ To gain acquaintance about the basics of Structural Equation Modeling.

Introduction

- ✔ SEM is a multivariate statistical analysis technique that is used to analyze structural relationships.
- ✔ SEM is the combination of factor analysis and multiple regression analysis.
- ✔ SEM is used to analyze the structural relationship between measured variables and latent variables.

Introduction

- ✔ SEM is preferred by the researcher because it estimates the multiple and interrelated dependence in a single analysis.
- ✔ SEM enables the researcher to include unobservable variables which were measured indirectly by the variables and facilitates error term attached to the observed variable.
- ✔ In this analysis, two types of variables are used: Endogenous variables and Exogenous variables.

Exogenous & Endogenous Variables

1. Exogenous variables

- assumed to be external to the model
- no other variable points at it in a model
- independent variables
- constitutes the periphery of the model

2. Endogenous variables

- predicted by other variables in the model
- directed arrow entering into them in a model
- dependent variables on one or more variables
- constitutes the inner core of the model

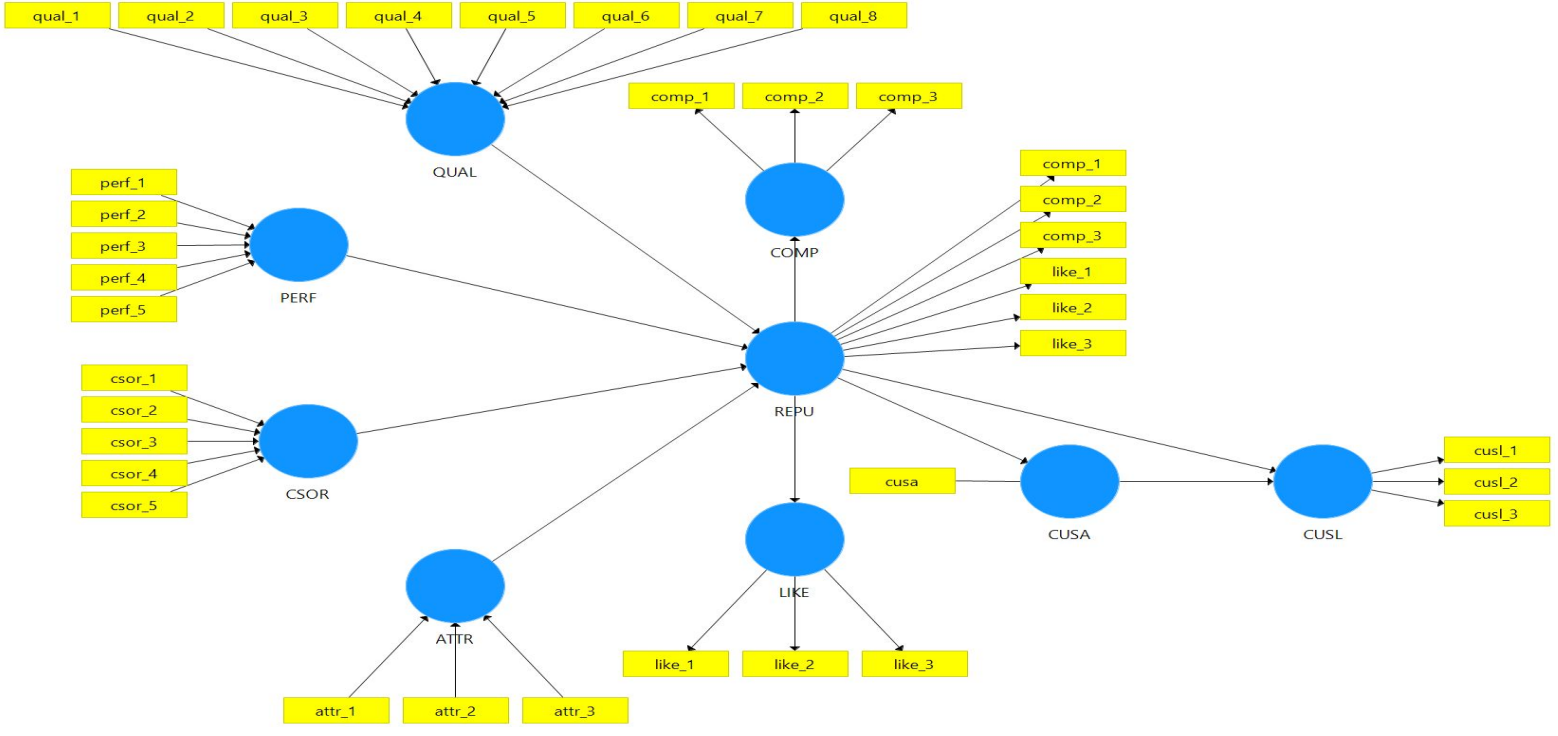
Types of Constructs in a Model

1. Observed Variables: are called as Indicators. (items or observed variables in SPSS & AMOS). Directly measured in SEM.

2. Latent Variables/Constructs: are abstract, not measured directly in SEM and represent the group of indicators.

Order of Constructs

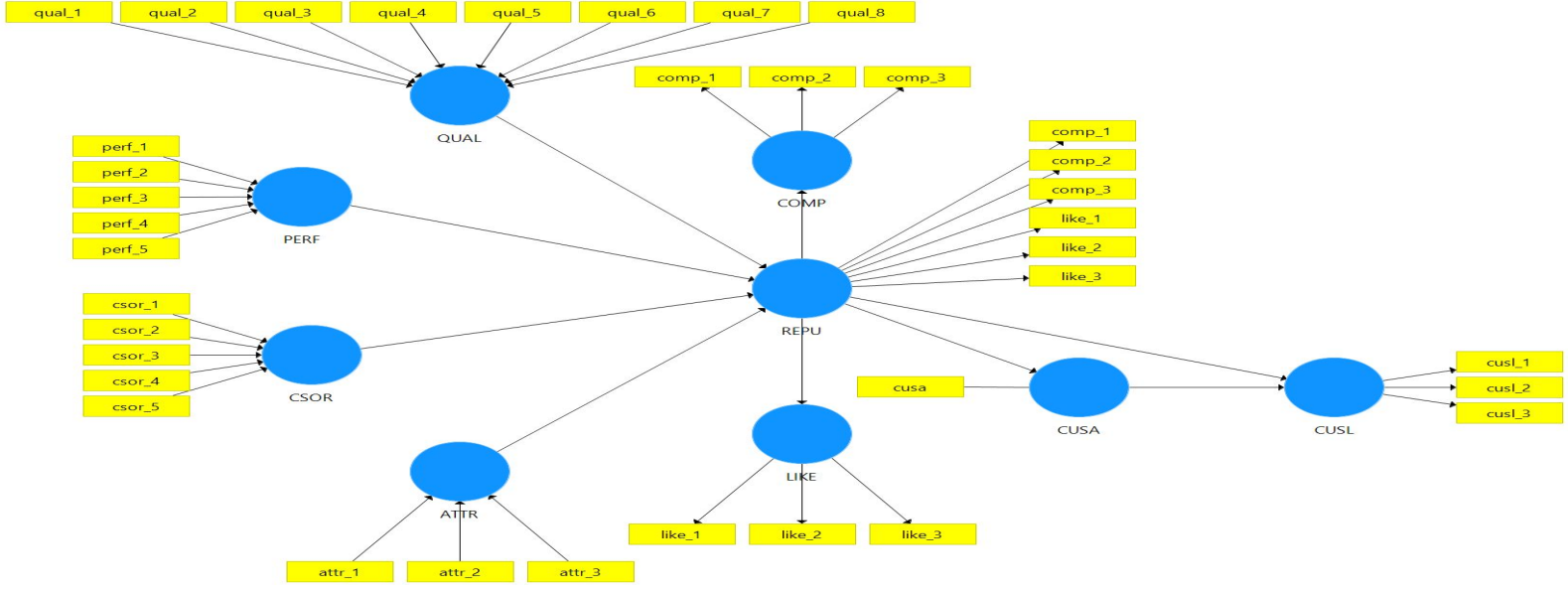
1. First Order Construct: Outer tier of latent variables / exogenous variables which are immediately attached with the indicators



Order of Constructs

2. Second Order Constructs or Higher Order Constructs:

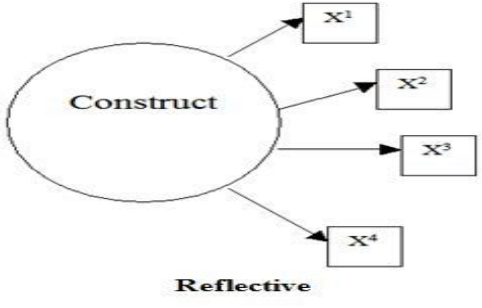
Constructs attached with the First Order Constructs are called Second Order Constructs.



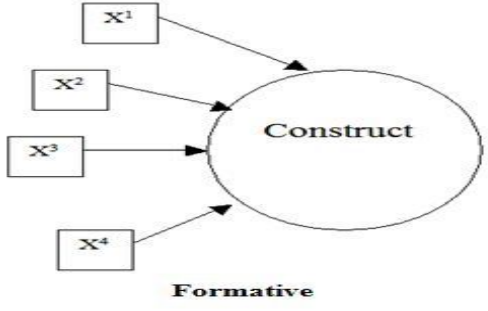
Types of Models

1. Reflective Models: If the indicators are caused by the latent construct and interchangeable among themselves. Multiple indicators direct outwards with their arrows directed from latent constructs to indicators.

2. Formative Models: If the indicators cause the latent construct and are not interchangeable among themselves. Arrows direct inwards fro



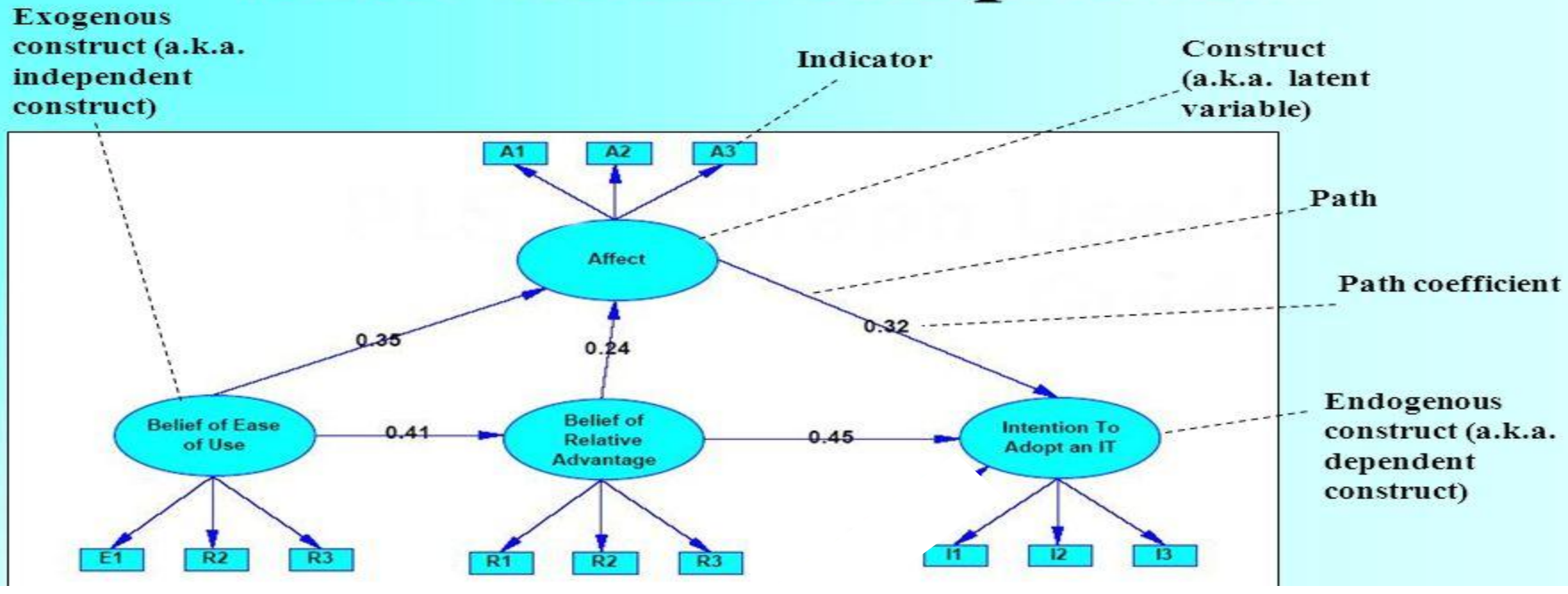
Reflective



Formative

Summary

SEM model components



SEM Softwares in Market

1. SmartPLS

2. R program

3. Lavaan (Latent Variable Analysis)

4. AMOS

```
library(lavaan)

model <- '
    # latent variables
      ind60 =~ x1 + x2 + x3
      dem60 =~ y1 + y2 + y3 + y4
      dem65 =~ y5 + y6 + y7 + y8
    # regressions
      dem60 ~ ind60
      dem65 ~ ind60 + dem60
    # residual covariances
      y1 ~~ y5
      y2 ~~ y4 + y6
      y3 ~~ y7
      y4 ~~ y8
      y6 ~~ y8
'
fit <- sem(model, data=PoliticalDemocracy)
summary(fit)
```

Types of SEM

1. Covariance Based SEM or CB-SEM

✔ CB-SEM is a covariance-based SEM applied to confirm or reject the already existing theories.

2. Partial Least Square SEM or PLS-SEM

✔ PLS-SEM is a variance-based SEM applied to propose new theories and added new facts and information to the research field (Hair et al., 2011).

Model Development

- ✔ A conceptual model is developed on the basis of relevant theory .
- ✔ Formulation of hypotheses to test the causal relationships among latent constructs and observed variables, which were also called as indicators.

Elements of SEM

✔ SEM is classified into two vital elements viz. Measurement Model Assessment and Structural Model Assessment.

I. Measurement Model Assessment

✔ Measurement Model is also called as CFA.

✔ It specifies relationships between indicators and constructs.

✔ Measurement Model explains how the latent constructs could be measured.

✔Assessment of Measurement Model is accomplished by establishing constructs' Reliability and Validity.

1. **Reliability of the Constructs:**

✔ Reliability measures the extent to which a test actually measures what it is expected to measure.

✔ It included assessment of internal consistency which was measured through Composite Reliability *(Lin and Ding, 2006),* Indicator Reliability (outer loadings).

✔ Composite Reliability (CR)>0.7 *(Hair et al.,1998; Fornell & Larcker, 1981)*

✔ Cronbach's α (CA) > 0.7 *(Nunnally & Bernstein, 1994)*

2. Validity of the Constructs: Refers to the ability of a research instrument to measure what it is designed to measure.

✔Measured through Convergent Validity & Discriminant Validity **(***Hair et al., 1998; Bagozzi and Edwards, 1998)*

a. Convergent Validity: Represents the degree up to which a measure correlates positively with other measures of the same construct. Recommended values for Convergent Validity are:

Factor loadings > 0.7, AVE >0.5

(Hair et al., 2010)

b. Discriminant validity: The extent to which a construct is truly distinct from other constructs by empirical standards.

✔Discriminant Validity can also be assessed through Fornell-Larcker Criterion (Hair et al., 2010).

✔According to this criterion, Square-root of AVE should be greater than the Inter-Construct Correlation.

✔Discriminant Validity can also be assessed through Cross Loadings i.e the loadings which it calculated on other constructs.

II. Structural Model Assessment

1. Assessment of collinearity issues of Structural Model

✔ The structural model is specified after assessing the validity and reliability of the reflective model through a measurement model.

a. Variance Inflation Factor *(Kline, 1998)*

VIF < 5 (Grewal et al., 2004; Hair et al., 2011), , *VIF = 1 / Tolerance*

b. Tolerance Value

- ✔ Tolerance Value is an indicator of how much of the variability of an independent variable is not explained by other independent variable in the model.
- ✔ *Tolerance level* > *0.2 (Hair et al., 2010).*
- ✔ *Tolerance Value = 1–R^2 for each variable*

2. Hypotheses Testing

✔Standardized Path coefficients (β) of the structural model represent the magnitude and direction of relationships and were thus used for Hypotheses Testing

✔t-statistics (>1.96) and significance levels at $p<0.05$.

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Any Questions ??

Thank You