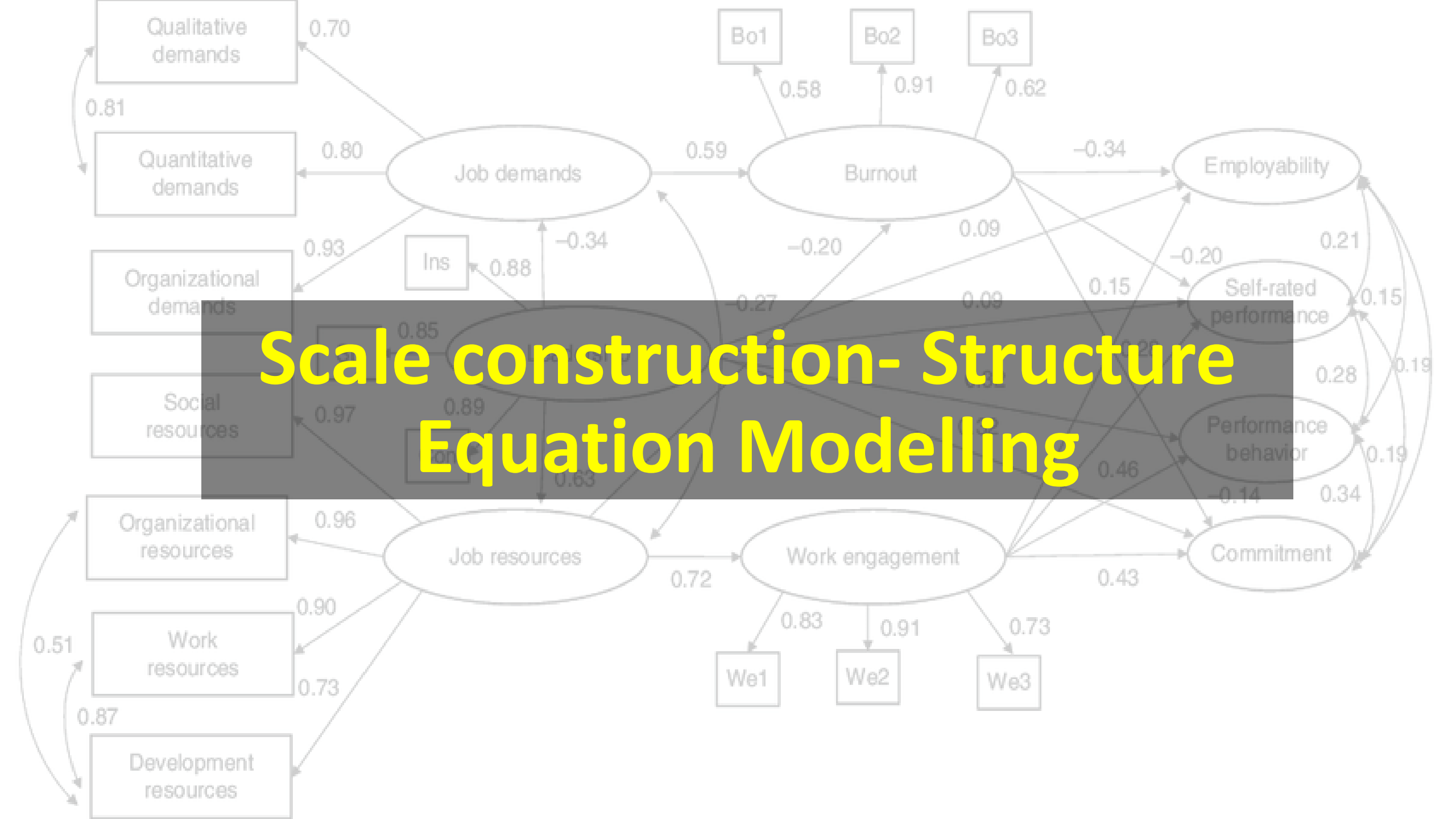
SEMINAR-III



Scale construction- Structure Equation Modelling

Objectives of seminar

01

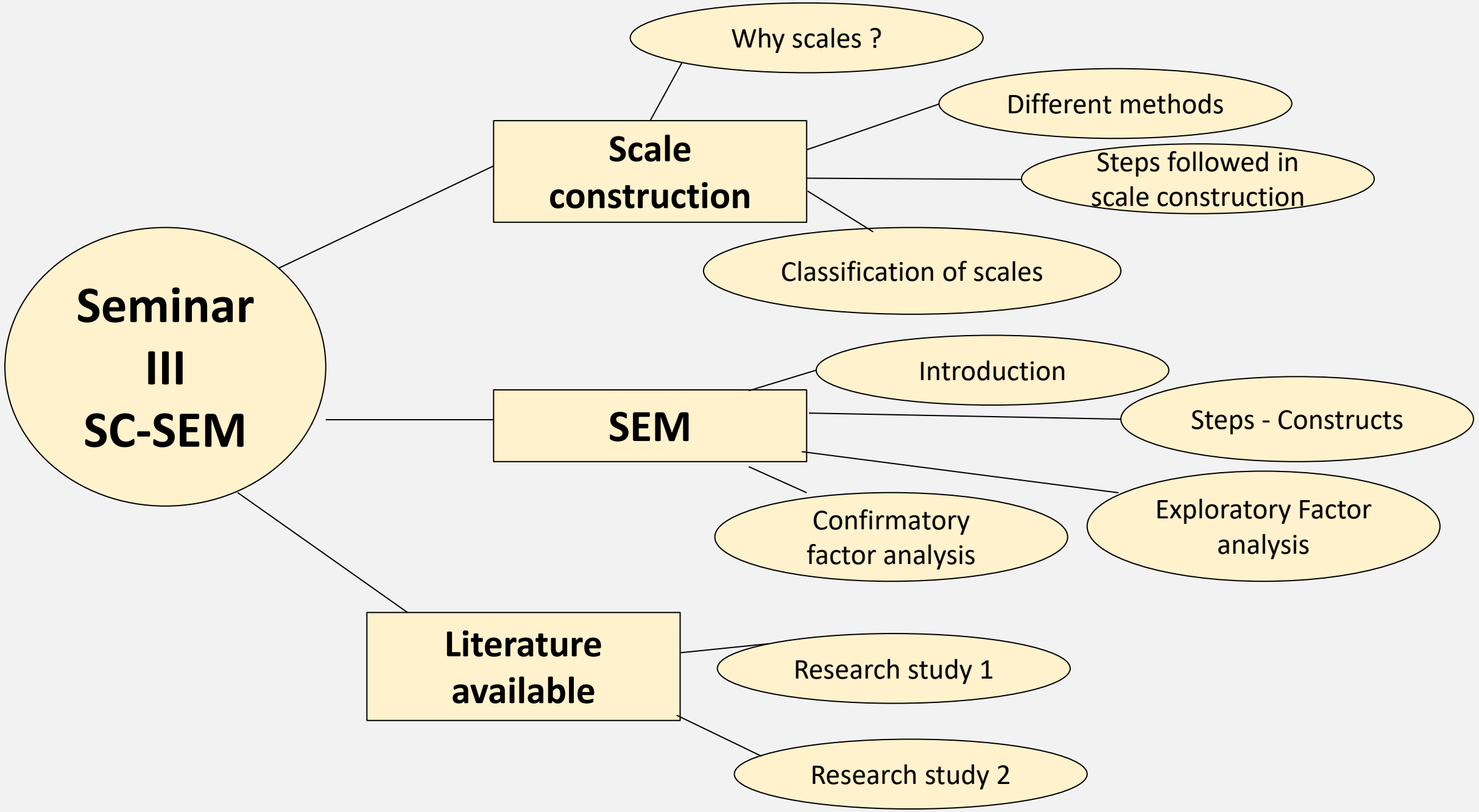
To understand the concept of scale construction in behavioral science

02

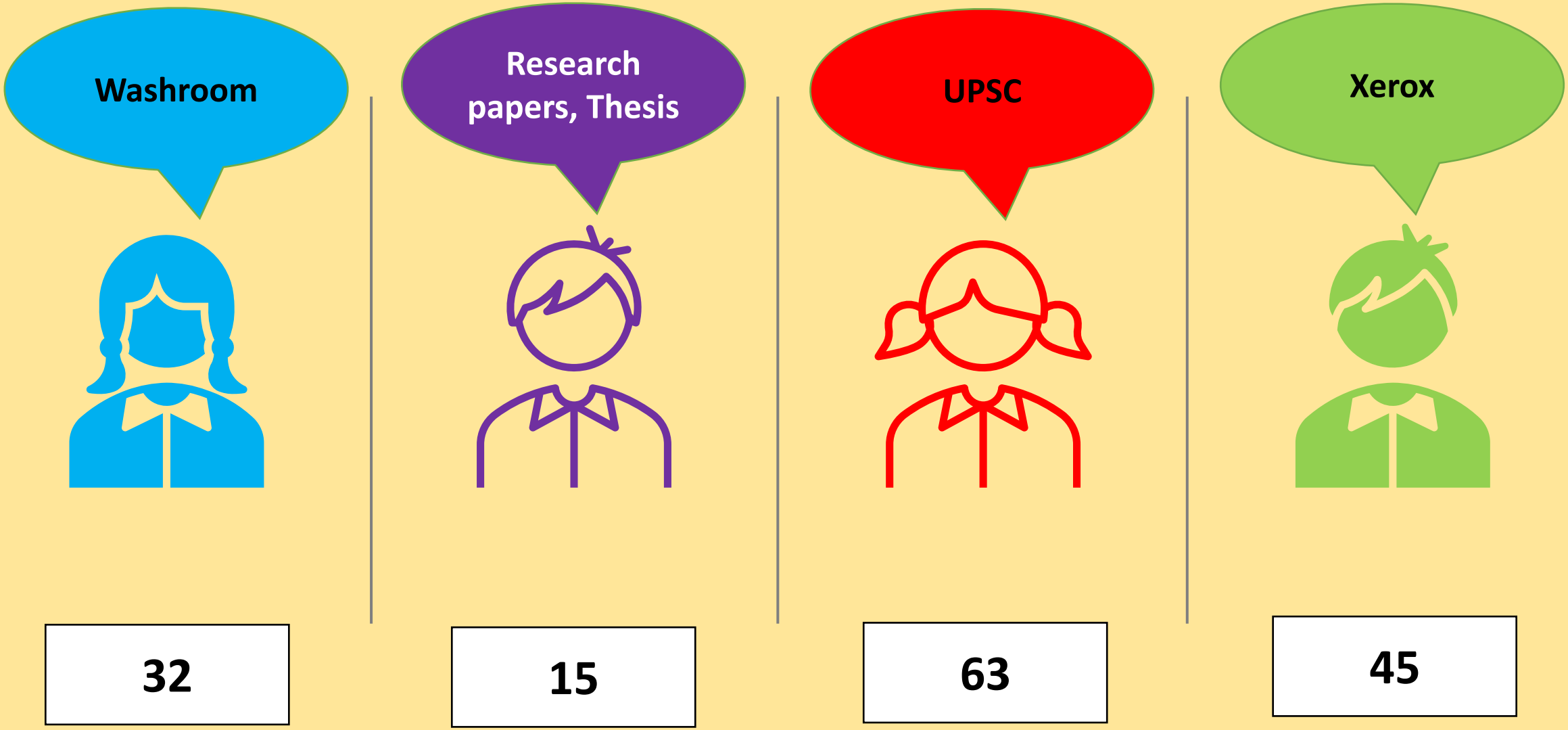
To understand the concept, procedure of Structure Equation Modeling (SEM) and its implications and challenges

03

To review the relevant literature available on SEM


Seminar
III
SC-SEM
Scale construction
Why scales ?
Different methods
Steps followed in scale construction
Classification of scales
SEM
Introduction
Steps - Constructs
Confirmatory factor analysis
Exploratory Factor analysis
Literature available
Research study 1
Research study 2

Utilization behaviour of University library recourses for research and agricultural literature


Washroom
Research papers, Thesis
UPSC
Xerox
32
15
63
45


Scale is needed to measure
the behaviour

Behaviour Variability

- All behaviour research attempts to answers questions behavioral variability – how and why behaviour varies across situation , difference among individuals and changes over time
  - ✓ Across situation – Adoption of varieties with or without subsidy conditions
  - ✓Among individuals / groups – Across farmers group
  - ✓Changes over time – whether the adoption sustain or replaced with another crop

Goal of scientific research

Goal	Description	Example
1. Description	1. To understand the phenomenon 2. Defining and classifying things	Describes a current and potential users for a product / technology
2. Exploratory	1. Limited or low knowledge about a situation or out come 2. Uncover the factors determining the situation or outcome	Reasons for decline in use of particular technology
3. Explanation/ Diagnostic	1. Establishing the casual relationships among variables using empirical data 2. Understanding the dynamics of the phenomenon	Understanding and explaining the factors i.e. personal, socio economic etc. responsible for success of village adoption programme interventions In village

Goal of scientific research

Goal	Description	Example
4. Prediction	1. Identifying relationships among variables of particular phenomenon 2. For estimating its outcomes in future (To predict)	To understand the effect of individuals, social and economic factors which determine adoption of a new technology
5. Application	1. Applying the knowledge – change behaviour of stakeholders	Action research

Scale Development = Exploratory + Explanatory + Prediction

Different methods of measuring

Direct method of questioning

Opinion on political party

Favourable	Undecided	Unfavourable

Edwards, Techniques of attitude scale construction ,Page 13 -14

Drawbacks of direct questioning

1

Sometimes individuals may not be aware their feelings toward a given psychological object.

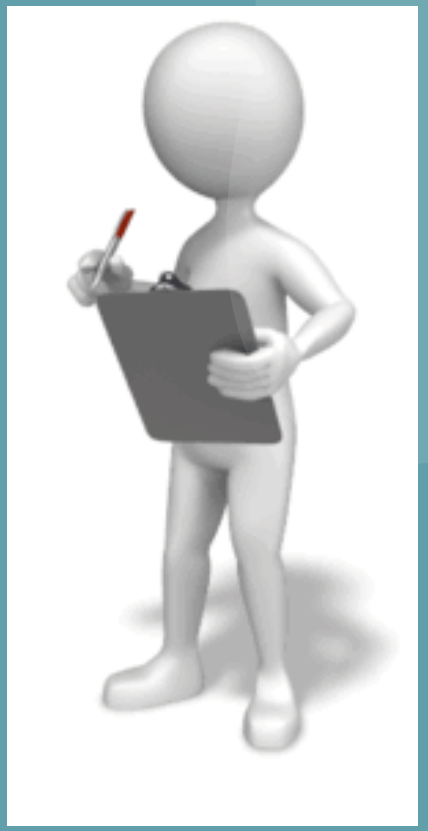
2

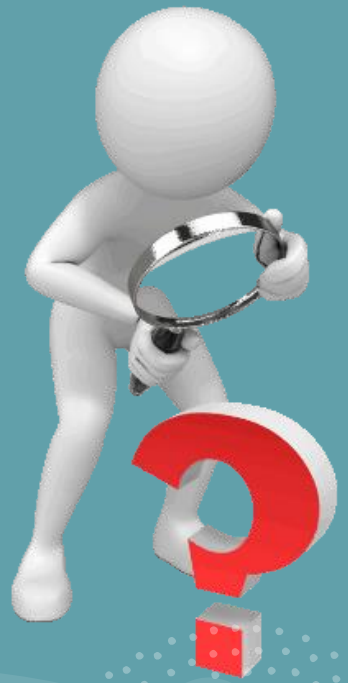
Our objects are so mixed and confused that it is difficult for us to evaluate how we feel.

3

Sometimes both positive and negative aspects towards psychological object

Direct Observation of Behaviour





Limitations

- Sample is large number
- Fish – not eaten – dinner
- Temple – husband – wife
- Man – paper – Editorial policy

Items / statements

The test contains to which we are asked to respond in some specified way.

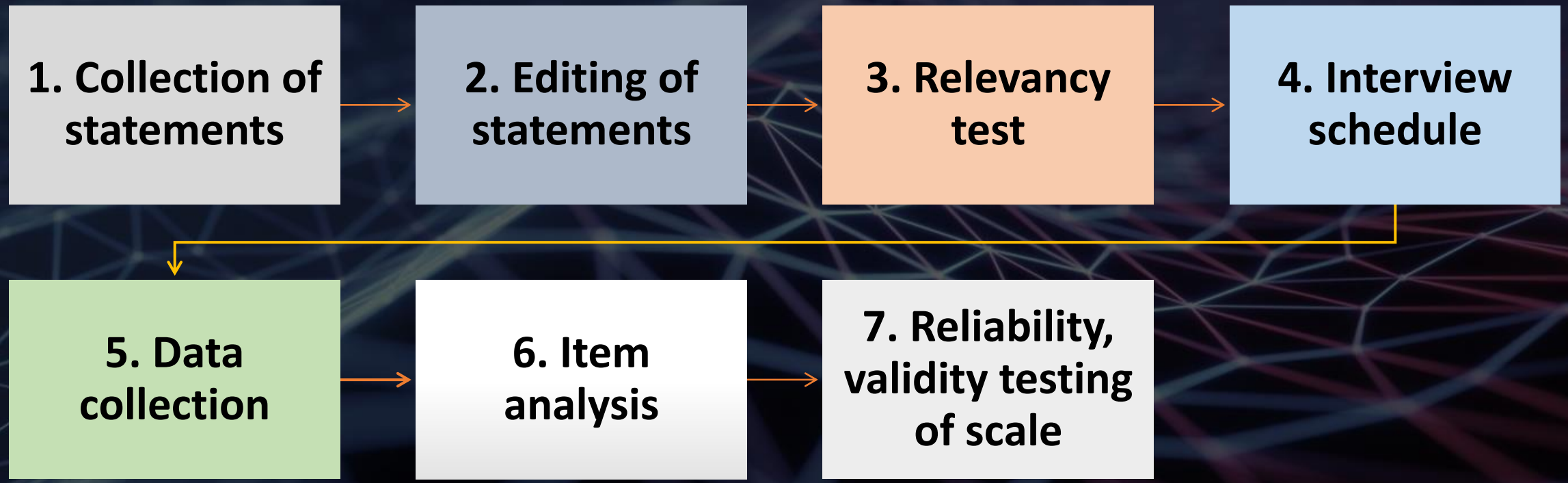
It contains degree of effect that individual that individual associated with psychological object

Belief and Disbelief system

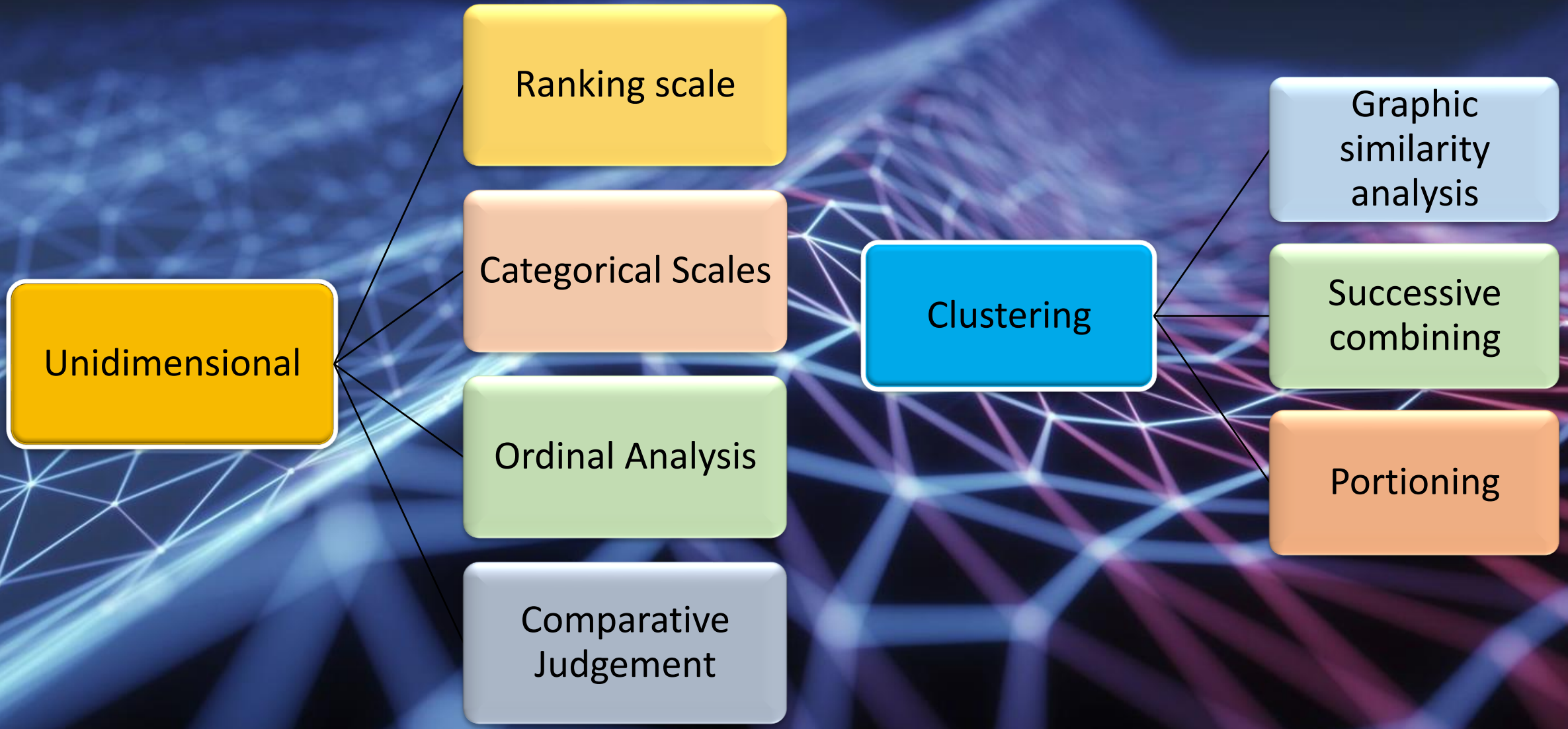
General methods in scale construction

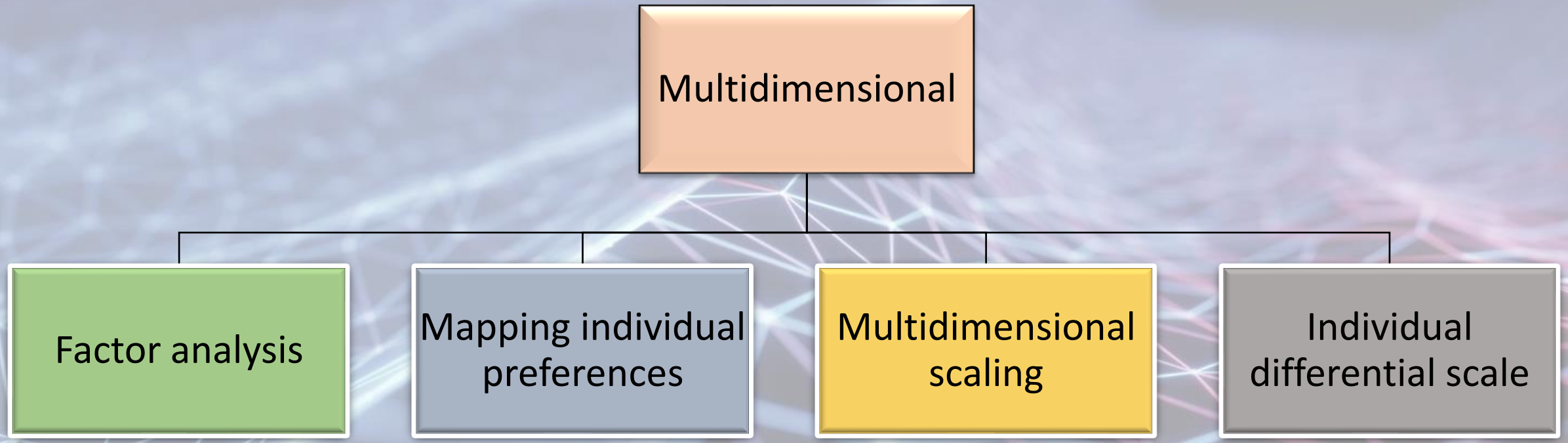
Paired comparison technique	**A or B, B or C , A or C – F matrix, P matrix and Z matrix**
Equal appearing interval scale	**Most favorable 1 2 3 4 5 6(Neutral) 7 8 9 10 11 Most unfavorable**
Scalogram analysis	**Unidimensional**
Q sort methodology	**Arranging statement in sequence**
Likert Summated rating	**Relevancy 80%, Mean value 0.75 / t value – >1.75**
Perceptual mapping	**Correspondence analysis- graphical representation of two way contingency matrix**
Saatys Analytical Hierarchy process and fuzzy AHP	**Last seminar**
Structure Equation Modeling	**Current seminar**

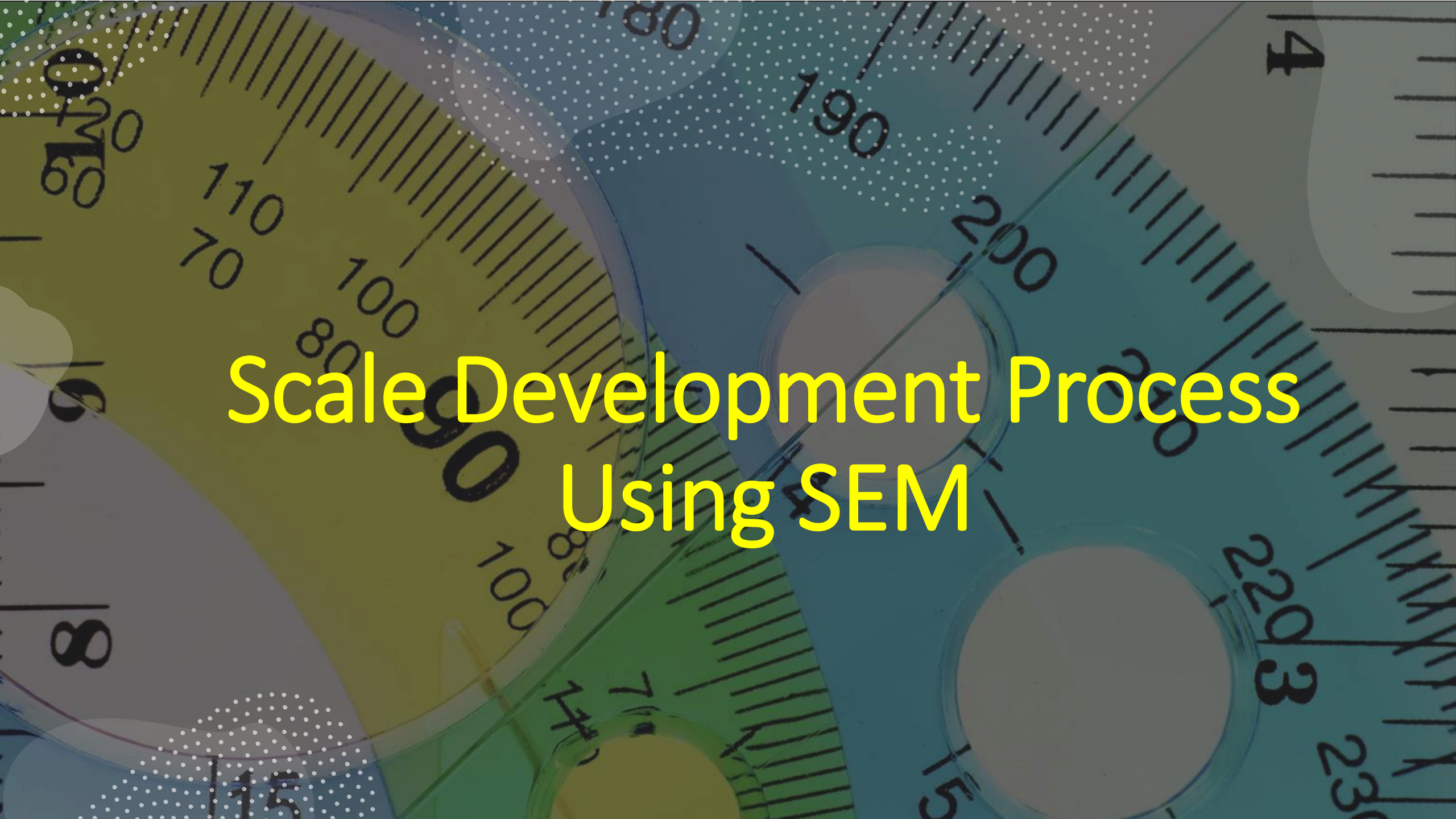
Steps to be followed during the scale construction



Scaling methods




Multidimensional
Factor analysis
Mapping individual preferences
Multidimensional scaling
Individual differential scale



Scale Development Process Using SEM

Structure Equation modeling

Multivariate technique combining aspects of factor analysis and multiple regression that enables researchers to simultaneously examine a series of interrelated dependence relationships among measured variables and latent constructs as well as between several latent constructs.

It is developing a scale using measuring a social phenomenon using casual approach.

It is measuring a process ex: Adoption of Technology – GM crops, Empowerment

Everything starts with one point and ends one point

Mostly we are giving weightage to end point and neglecting the first points

Training programme ----------→ adoption technology

Adoption is mental process and continuous process

SEM is all about focusing on the constructs that involved and its relationships.

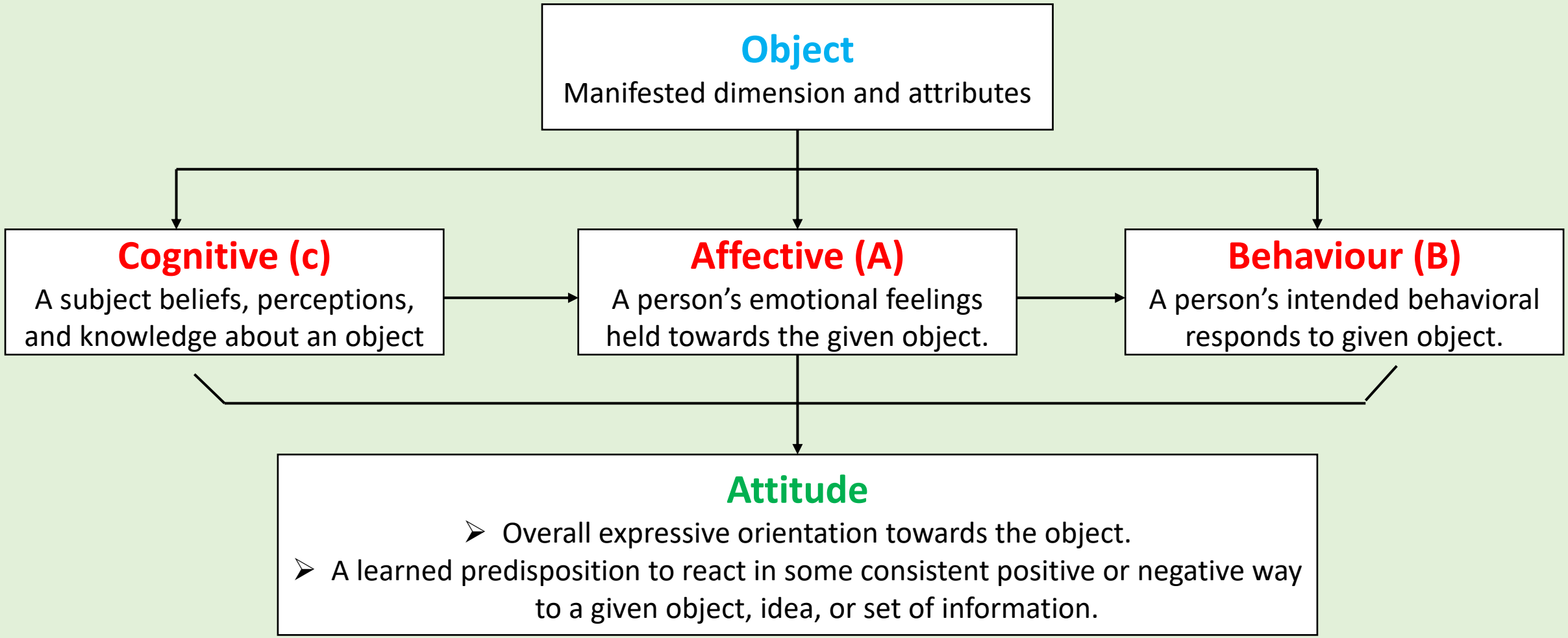
Entrepreneurial Competence

- Persistence
- Information seeking
- Problem solving
- Self confidence
- Persuasion
- Use of influence strategies
- Efficiency orientation
- Coordinating ability

1. Identification and definition of a viable market niche
2. Development of products of services appropriates to the firms chosen market niche/ product innovation
3. Idea generation
4. Environmental scanning
5. Recognizing and envisioning taking advantage of opportunities
6. Formulating strategies for taking advantage of opportunities

(Mitchelmor and Rowley, J. (2010), "Entrepreneurial competencies: a literature review and development agenda", *International Journal of Entrepreneurial Behavior & Research*, Vol. 16 No. 2, pp. 92-111.)

Trilogy of Attitude



Step 1: Item Generation
Create Items

Step 2: Content Adequacy Assessment
Test for conceptual consistency of items

Step 3: Questionnaire Administration
Determine the scale for items
Determine an adequate sample size
Administer questions with other established measures

Step 4: Factor Analysis
Exploratory to reduce the set of items
Confirmatory to test the significance of the scale

Step 5: Internal Consistency Assessment
Determine the reliability of the scale

Step 6: Construct Validity
Determine the convergent and criterion-related validity

Step 7: Replication
Repeat the scale-testing process with a new data set

→ Literature review / Experts / Focused group discussion

→ Face and content validity

→ Pilot study and initial reliability estimation

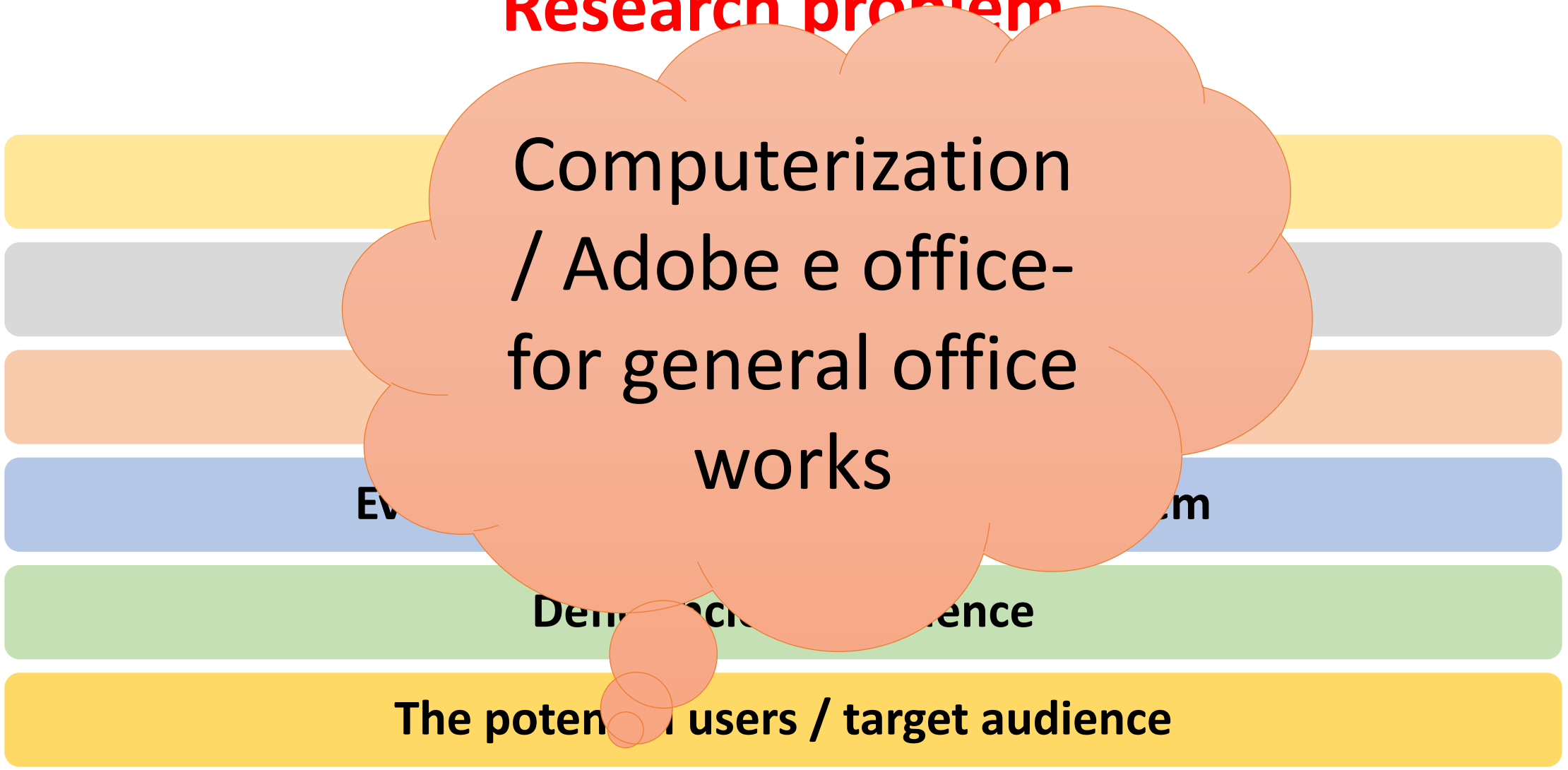
Churchill, G. A. (1979). *A Paradigm for Developing Better Measures of Marketing Constructs. Journal of Marketing Research, 16(1), 64.* doi:10.2307/3150876

→ Cronbach alpha

→ Confirmatory factor analysis

→ Validation

Research problem



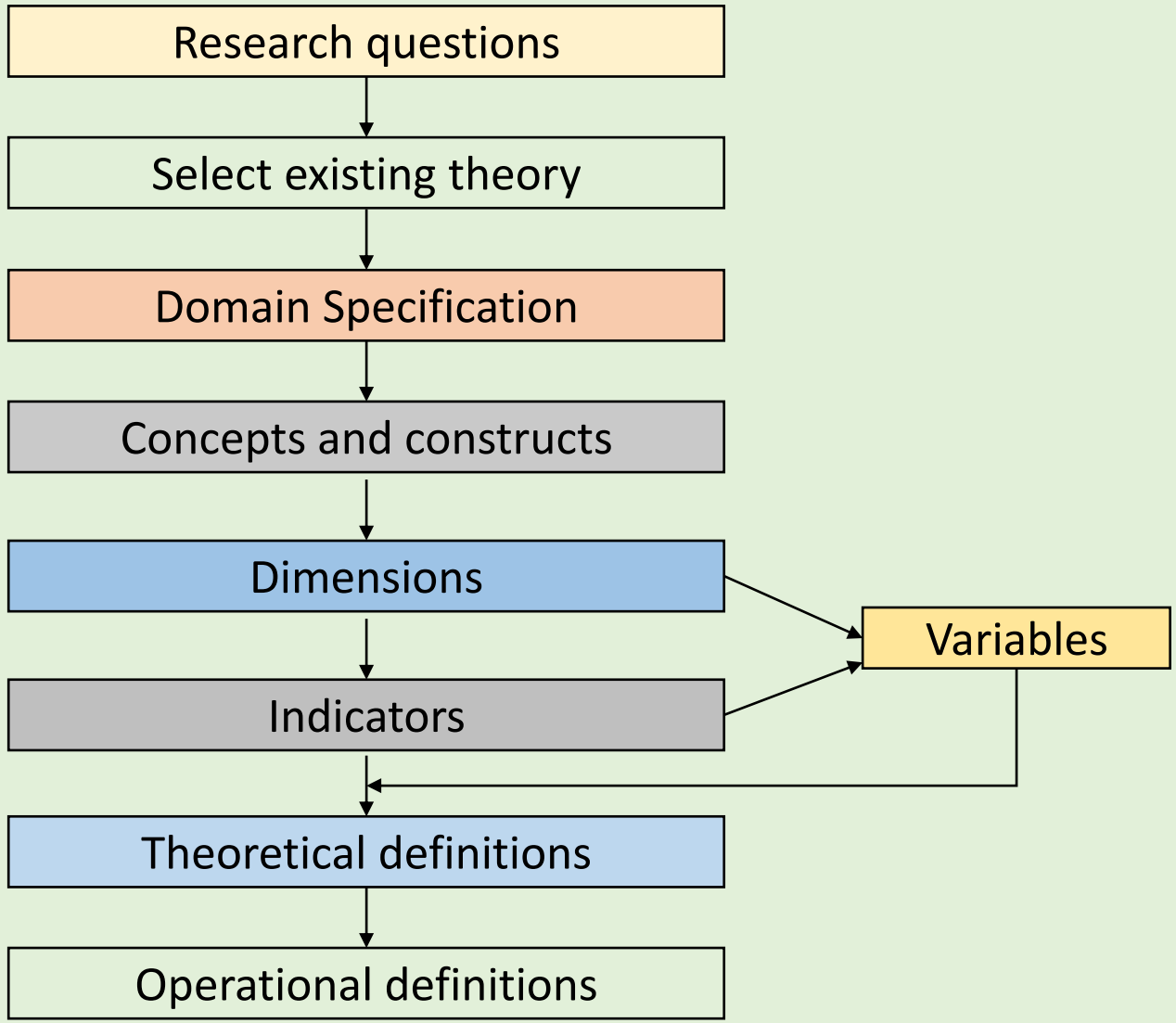
Research purpose and objectives

Purpose: To develop a model of adobe technology/ digitalisation/ computer acceptance which can help administrators to enhance use in organization .

Objectives:

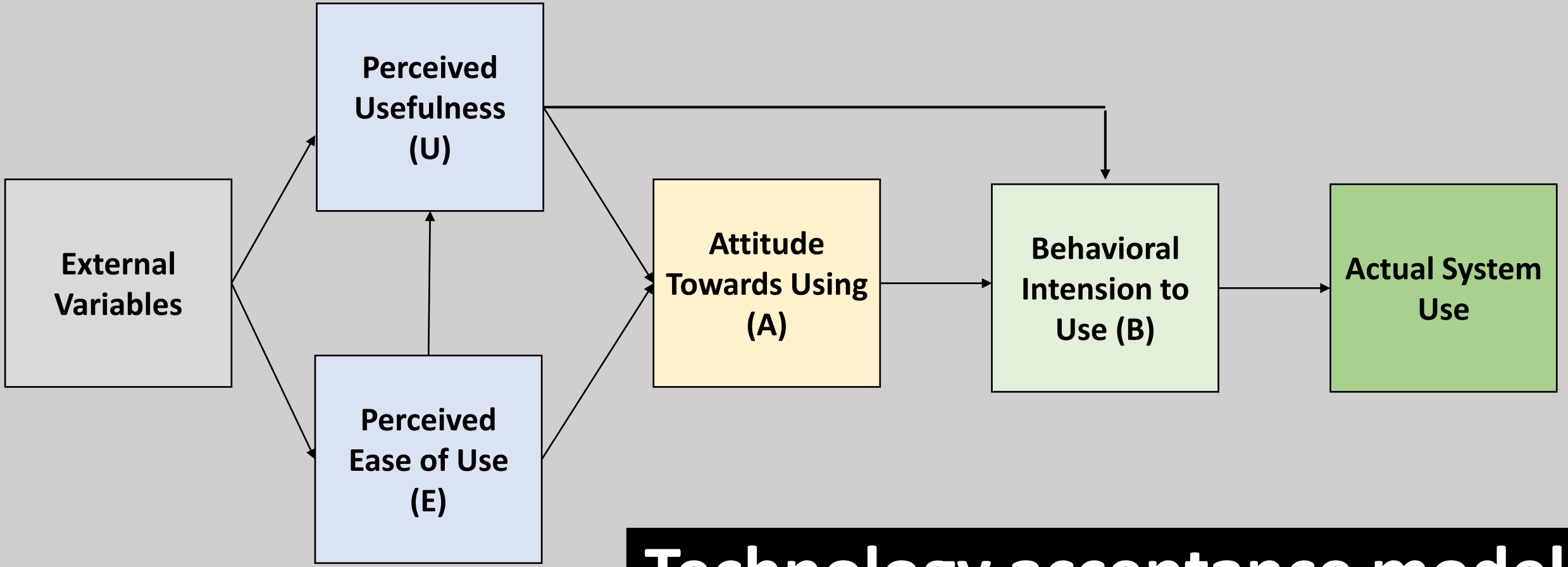
1. To study the profile characteristics of members in organization .
2. To assess the existing computer infrastructure and computer competences of members in organization.
3. To measure the computer utilization behaviour of members in organization
4. To study the attitude of members towards computerization of general work process
5. To identify the factors that influencing the computerization of system

Construct conceptualization



Theory selection

Social Cognitive theory (SCT)	→	Bandura (1982) **Self efficacy** – Attained through direct experience
Theory of reasoned action (TRA)	→	Ajzen and Fishbein (1980) Behaviour is determined by his / her **behavioral intention** (Symbolic adoption)
Technology acceptance model (TAM)	→	Davis (1989) Computer usage is determined by behavioral intention (**function of PU and PEU**)



Technology acceptance model (DAVIS, 1989)

Specification of Domain

Boundary drawn by Conceptual Narrowing or Broadening

In terms of space, time, assumptions/ values about the nature of the phenomenon

Domain- Computer utilization of Behaviour of members working in UAS bangalore

Constructs – From literature review

Variables	Items	Studies
Computer Access	AT work, Do you use • Own terminal • PC • Common facility	Cuplan (1995)
Computer experience	• Word processing • Internet • Search engines • Hypermedia • Spreadsheets • Databases • Computer graphics • Computer graphics • Computer games • Telecommunication	Reed & Giessler (1995), Reed et al (2000), Hasan (2003) and Law & Huang (2003)

Variables	Items	Studies
Computer training	The company, college courses, vendors training, in – house training, Benson self training, Outside training, Outside training	Benson (1983), Nelson & cheney (1987), Lgbaria et al (1990) and culpan (1995)
Computer use	• Intensity of use • Frequency of use • Diversity of software packages used	Igbaira et al (1989), Igabaria (1990), Ghani (1992), Blili et al (1998), Suh et al (1994)
Perceived Usefulness	• Using the computer in my job would increase my productivity • Using microcomputers improves my job performance • Using microcomputers provides me with information that would lead to better decisions	Davis (1989), Igbaria (1990), Davis et al (1989) and Yi & Hwang (2003)
Perceived ease of use	• Computers are easy to use • Interacting with the electronic mail system requires a lot of my mental effort	Davis (1989), Compeau & Higgins (1995)
Computer anxiety	• Computer not scares me at all • Working with computer makes me nervous • I am not the types to do well with computer	Loyd & Gressard (1984) & Temple 1989

Variables	Items	Studies
Computer Affect	Semantic differential scale	Kay (1993)
Computer self-efficacy	Modified version of computer self efficacy scale	Murphy et al (1989), Tokzadesh & koufteros (1994), Durndell & Haad (2002)

Identification of Concepts

- Concepts

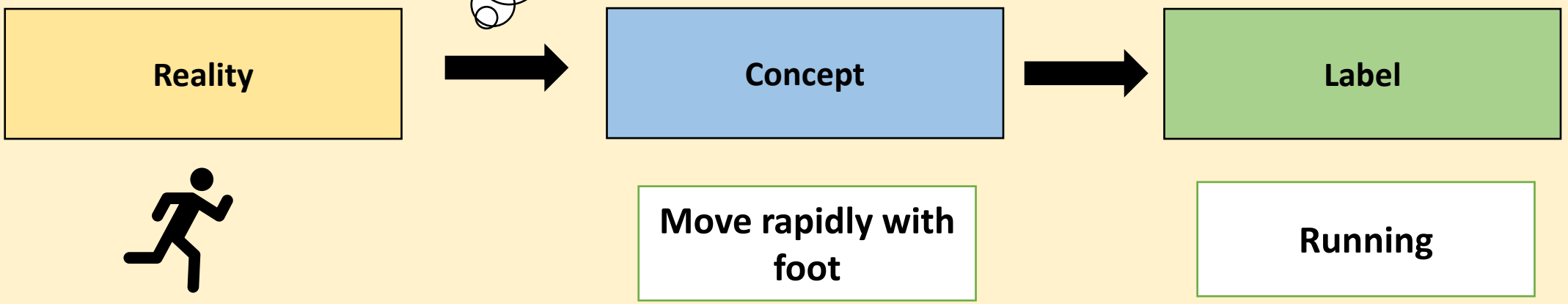
➢ Labels or terms formed in the minds of researcher to present various aspects of the reali

- Two componen

➢ Abstractions fo rom particulars of reality

➢Labels of the co

Abstraction
(By visual observation)



Constructs

Construct

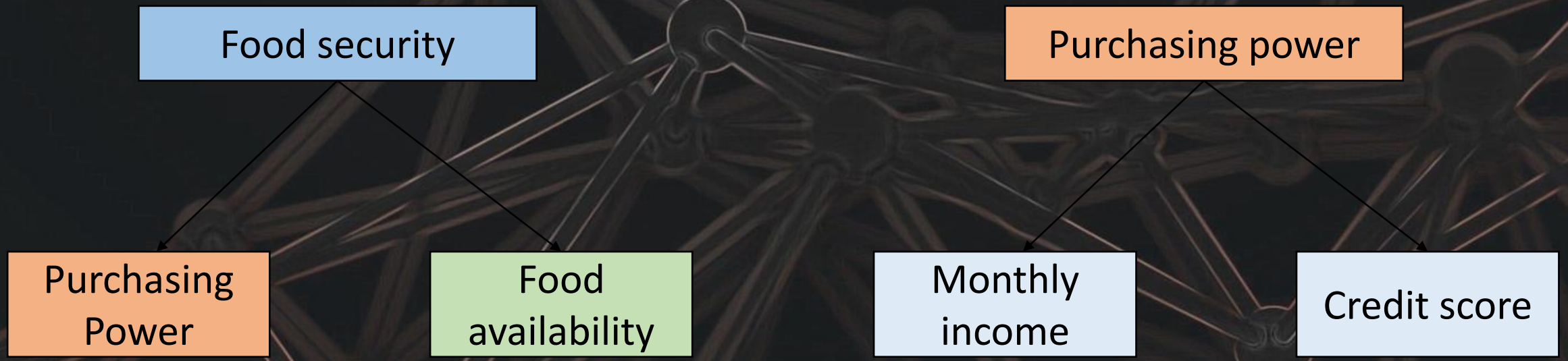
- Special types of concepts while deliberately consciously invented or adopted for a scientific purpose
- Abstract and indirectly observable through configuration of multiple observable entities

Dimension

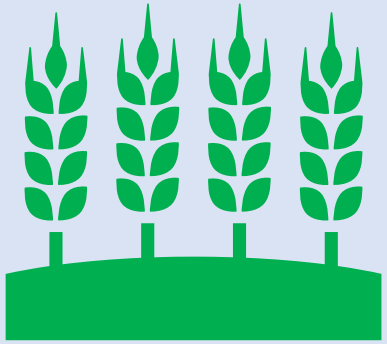
- Specific aspects of the concept
- A concept may have more than one dimension

Indicators

- Indicators are concrete and observable forms of concept which we use to explain the concept
- Common in multi dimensional concepts



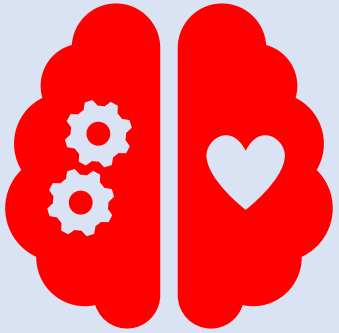
Specifying constructs
Ways of Conceptualizing a Phenomenon (Kaplan, 1964)



Concrete and directly Observable (Yield)

Concrete and Indirectly observable (Wealth, Heartbeat)

Abstract and Indirectly observable through Configuration of multiple observable entities (Empowerment, Behaviour)



Abstract and Indirectly observable by theoretical interpretation (God, Intelligence)

Identification of constructs

- From established theories
- For new phenomenon under study – Exploration through target population interview using FGDs and Thematic analysis

Validation of selection
Content Adequacy Assessment

Variables Vs Attributes

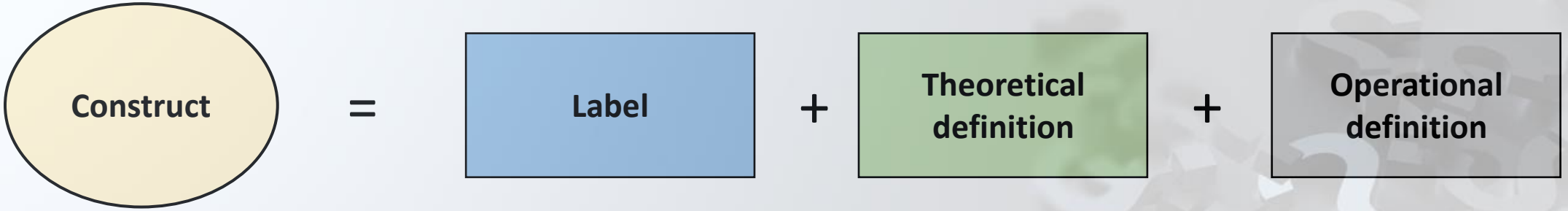
Attributes: They are characteristics or qualities that describe an object or person

E.g.: Female, Indian, Farmer etc

Variables: Logical grouping of attributes. (Which varies with individual)

E.g.: Gender, Race/Nationality, Occupation

Definition



- Labels: Formed based on meanings of both theoretical and operation definition
- Theoretical definition: Specifies the verbal meaning attached to the concept label
- Operational definition: Translate the verbal meaning provided by the theoretical definition into a prescription for measurement .
  - Describes the unit of measurement (e.g., Minutes, counts, weights, height)
  - Specifies the level of measurement (e.g. Binary, Nominal, Ordinal)

Premises , Proposition and Hypotheses

Premises

- Assumptions about how the different elements of a phenomenon interact relation to each other
- Sources – empirical finding coming from past studies, established principles, theoretical views suggested by people, or just assumption of the researcher.

Ex: Entrepreneurial behaviour rural youth depends upon their entrepreneurial traits

Propositions

- Statements of prediction or statement specifying conjectural relationship between concepts in a theory
- Logically derived from premises (Part of verbal world)

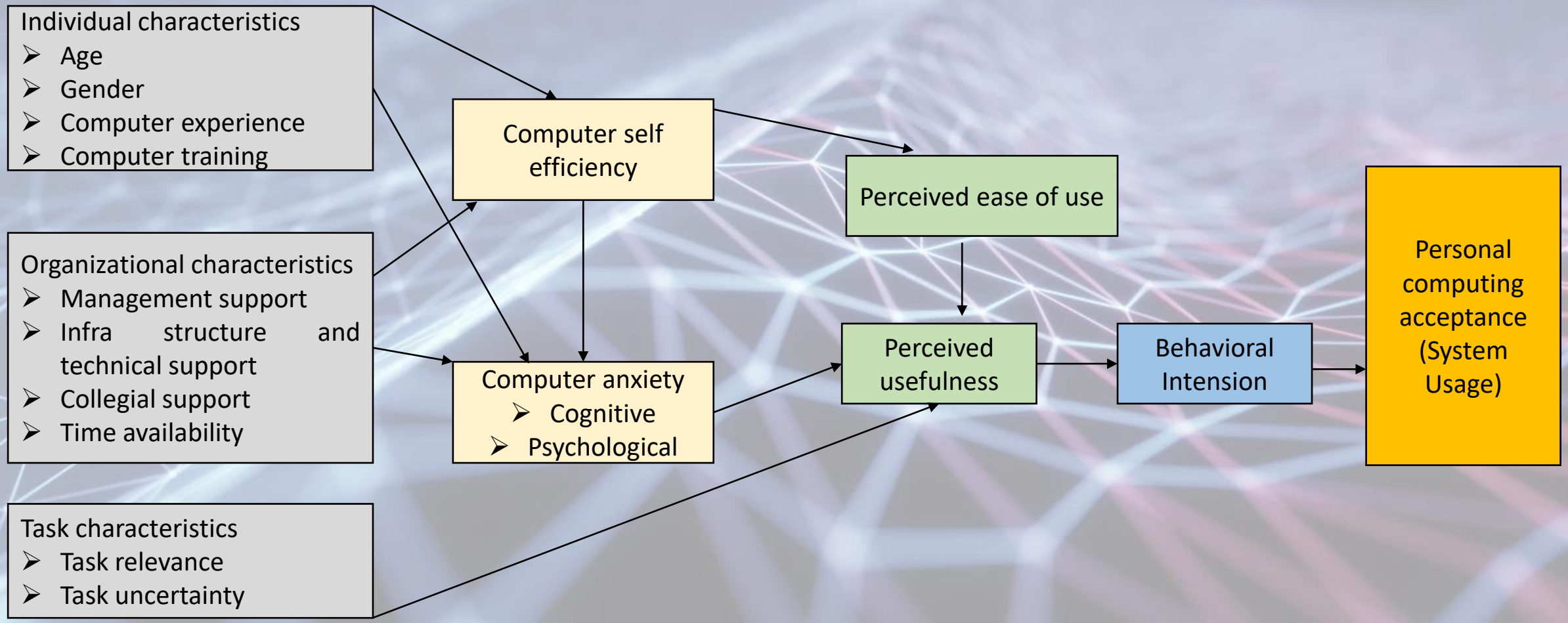
Ex: Entrepreneurial behaviour rural youth is positively related to their entrepreneurial traits

Hypotheses

- Conjectural statement about the relationship between variables
- Part of measurement world

Ex: Entrepreneurial behaviour score of rural youth is positively related to their entrepreneurial traits scores

Initial Model of computer use for Memebers



Content Adequacy Assessment – Content Validity

Content Validity

- Degree to which the contents of the research instrument or scale measuring the concept under study

Expert judgement methods

- Item –Objective congruence method (Rovinelli and Hmbleton, 1977)
- Lashes' Content validity ration (Lawshe, 1975)

Item – Congruence Index

The judge's rating data used to compute the index of item-objective congruence or item – sub scale congruence (for each item) using following (Martuza, 1977). (+1, 0, -1)

$$I_{ik} = (M - 1) S_K - S'_k / 2N (M-1)$$

Where

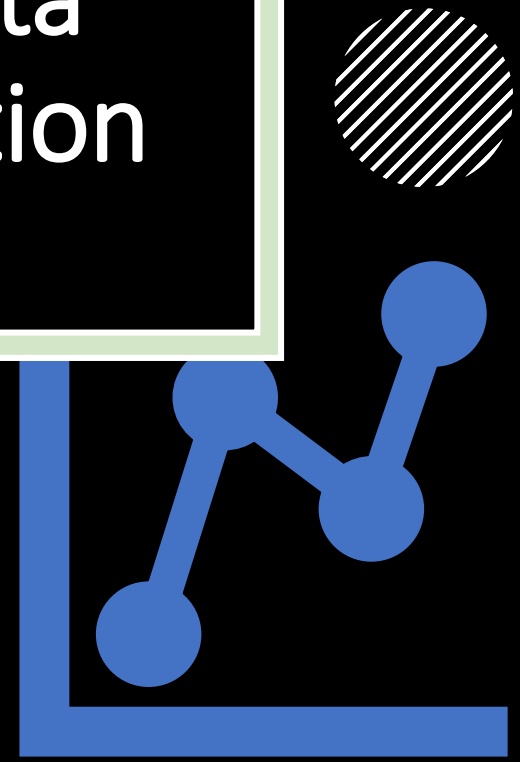
I_{ik} – Index of item – objective congruence
M – Number of sub – scales
N – Number of content specialists
S_k – Sum of ratings assigned to item k
S'_k – The sum of the ratings assigned to all objectives, except objective k

- The limits of index range from -1.00 to +1.00
- The threshold value (Cut-of) for selecting items for each competing objective or sub-scale is decided by the researcher.
- A value of 0.75 is usually selected as threshold and item-congruence value above 0.75 for a specific objective / sub-scale is selected while others are discarded.

Pre - testing and initial reliability estimation

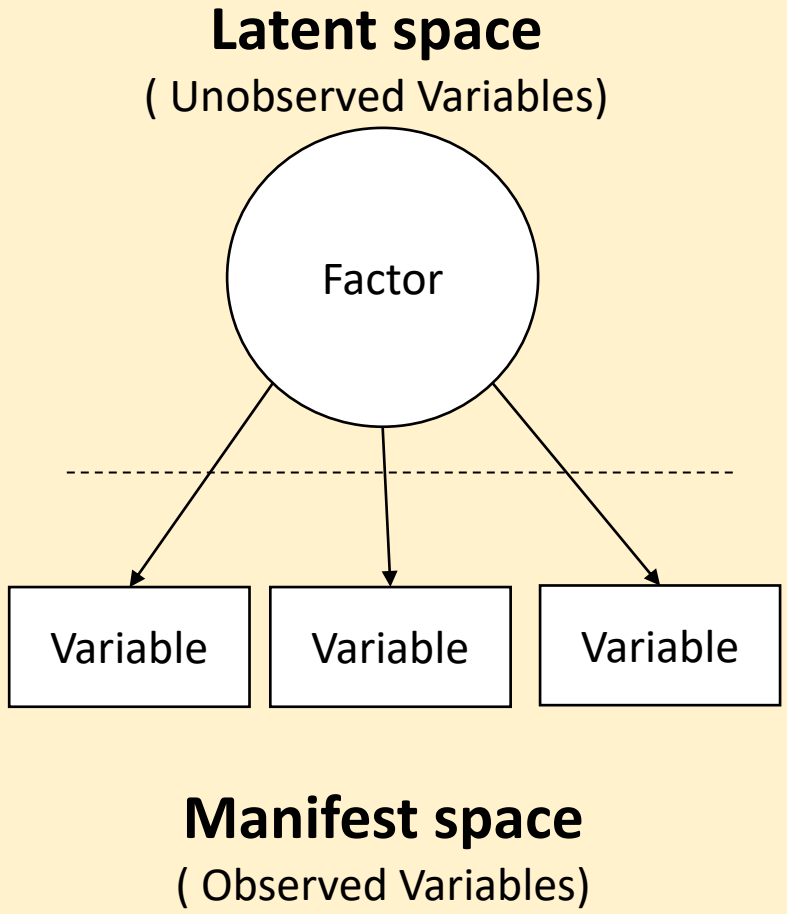
- ✓ Purpose - To detect problems in the questionnaire instruction or design whether the respondents have any difficulty in understanding the questionnaire or whether are any ambiguous or biased questions
  - ✓ Minimum sample size – 30
  - ✓ Reliability – Cronbach alpha

Data collection and Data preparation



- Data collection- Questionnaire, Personal interview, Online survey etc.
- Data preparation
  a. Variable identification
  b. Missing data treatment
  c. Outlier treatment
  d. Testing assumptions for statistical analysis
  e. Data transformation

Latent variable Models

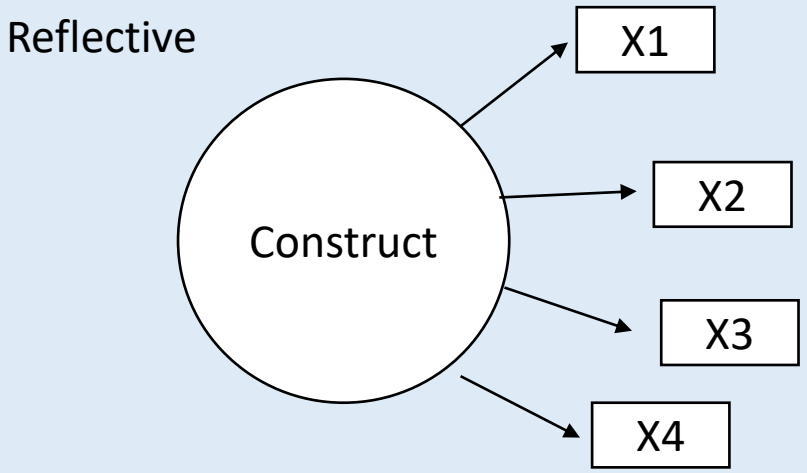


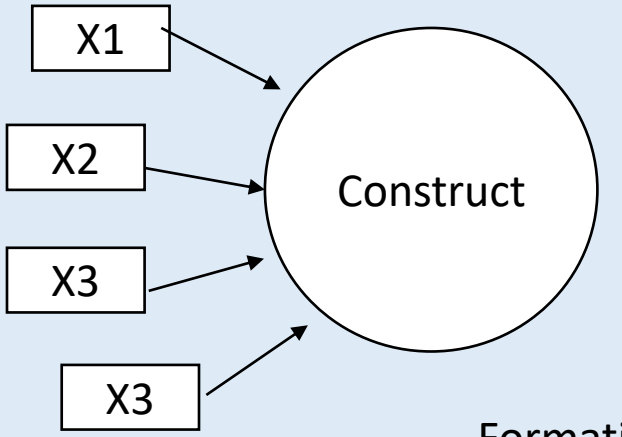
- Statistical model that relates a set of observable variables / Manifest variables to a set of latent variables.

Observed variable	Latent variables	
	Continuous	Discrete
Continuous	Factor Analysis / Structural Equation Modeling	Latent profile analysis / Mixture modeling
Discrete	Item response theory / Latent Trait Analysis (Discrete Factor Analysis)	Latent class analysis

Source: Bartholomew and Knott (1999)

Formative Vs Reflective constructs





Formative

Reflective construct

- The latent construct causes the indicators
- Highly correlated indicators
- Used in psychology

E.g.: Empowerment, Attitude towards GMO

Formative construct

- Indicators cause the construct
- Index of weighted sum of variables
- Indicators may or may not be correlated
- Used in economics and sociology

E.g. : Vulnerability Index

Exploratory factor analysis

Variables / item selection

- ✓ Suitable for metric and continuous variables (Interval ratio)
- ✓ For non – metric variables (nominal and ordinal) Dummy variable – Boolean factors
- ✓ Select relevant and meaningful items – Only after content validity assessment

Sample size requirement

- ✓ Absolute sample size - >200 (Barrett, 2007)
- ✓ N:q formula – N –ideal sample size and q- no of parameters estimated (variance, regression coefficients etc) – ideal – 20:1 (Jackson, 2003)
- ✓ Minimum 5 observation for item / Ideal is 10 sample per item

Correlation among variables

- ✓ Calculate a correlation matrix among variables to test suitability of data for FA
- ✓ The item correlation should be >0.30
- ✓ >0.70 we have to merge

Statistical assumptions

- ✓ To check if there are significant correlation among the variables (> 0.30)
  - ✓ Inter correlation matrix (r>0.30)
  - ✓ Bartlett's tests of sphericity – significant (p < 0.05)
  - ✓ Kaiser – Meyer – Olkin (KMO) measure of sampling adequacy – 0.6 to 1

Deriving Factors and Assessing Overall fit

Selecting the factor extraction method

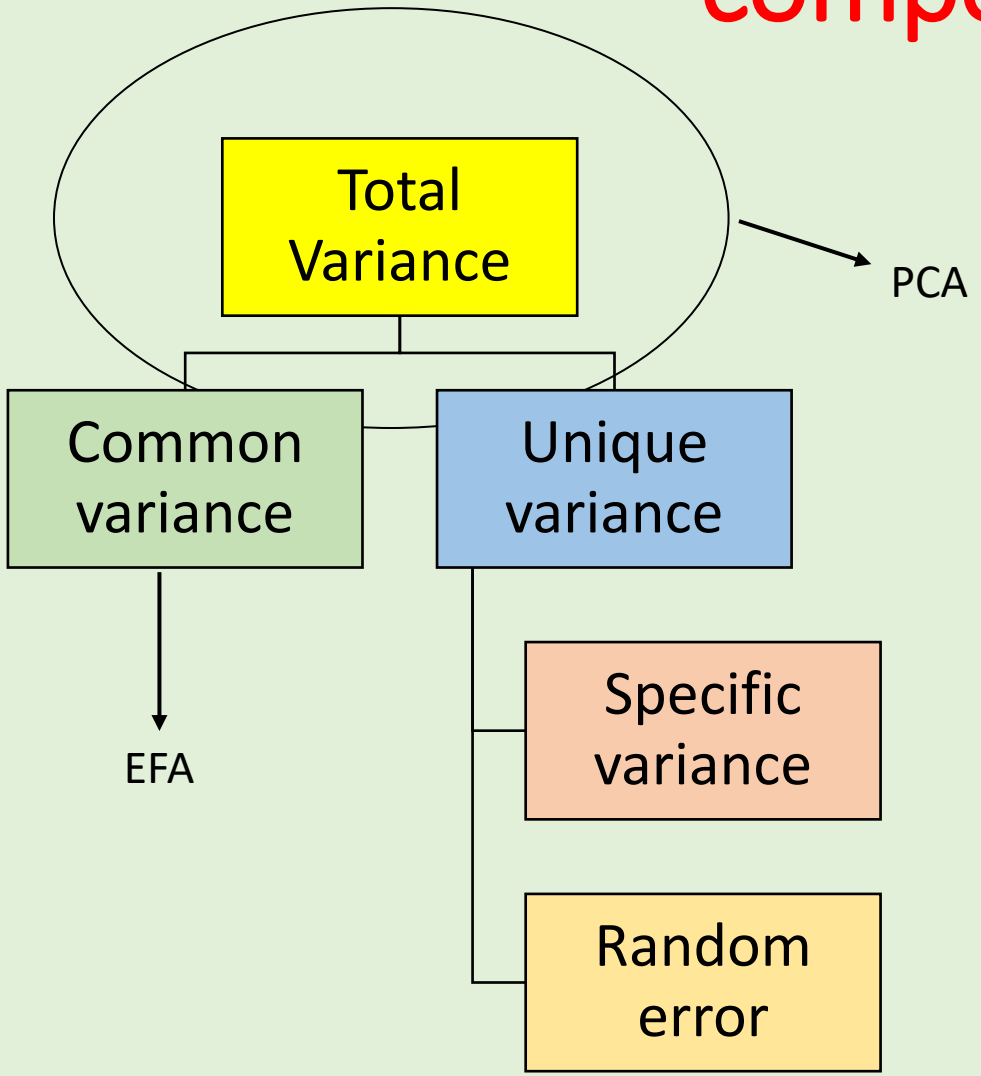
Exploratory factor analysis – Maximum Likelihood method: Promax rotation

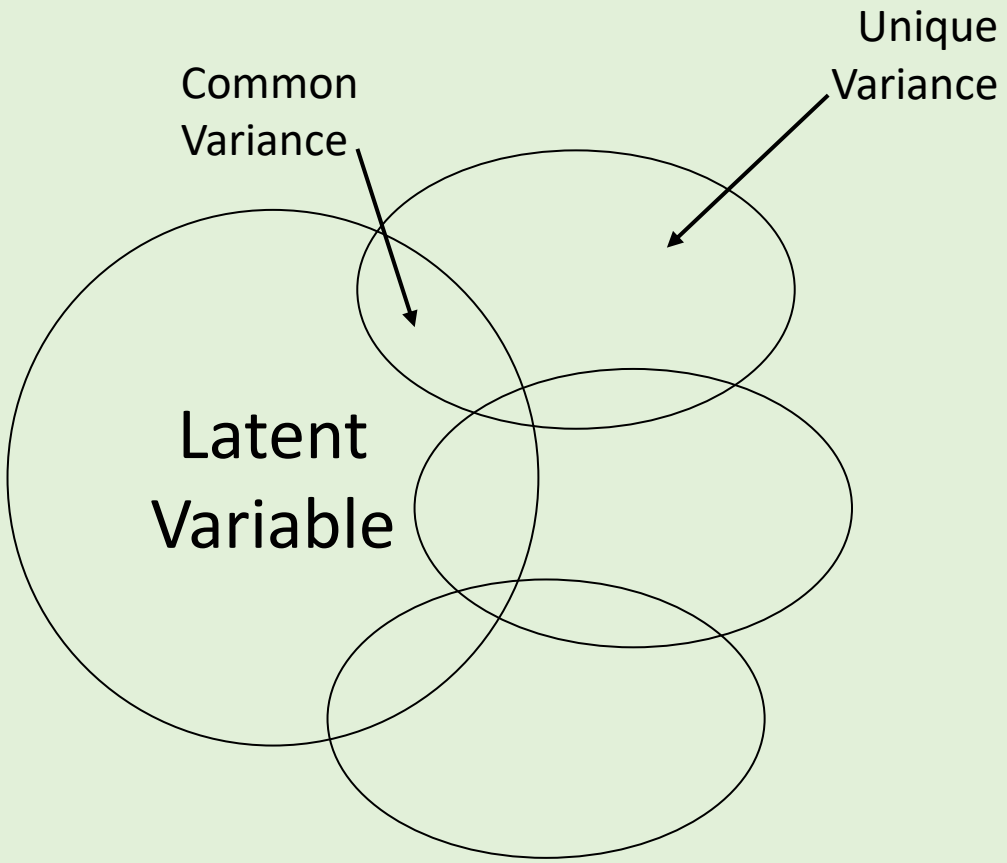
Selection between these two depends on two criteria

- ✓Objectives of factor analysis – Data summarization or reduction
- ✓Variance in the variables – Common variance and Unique variance

Total variance = Common variance + Unique variance + Error variance

Exploratory factor analysis vs Principal component analysis





Criteria for number of factors to extract

Latent toot or eigen value criterion

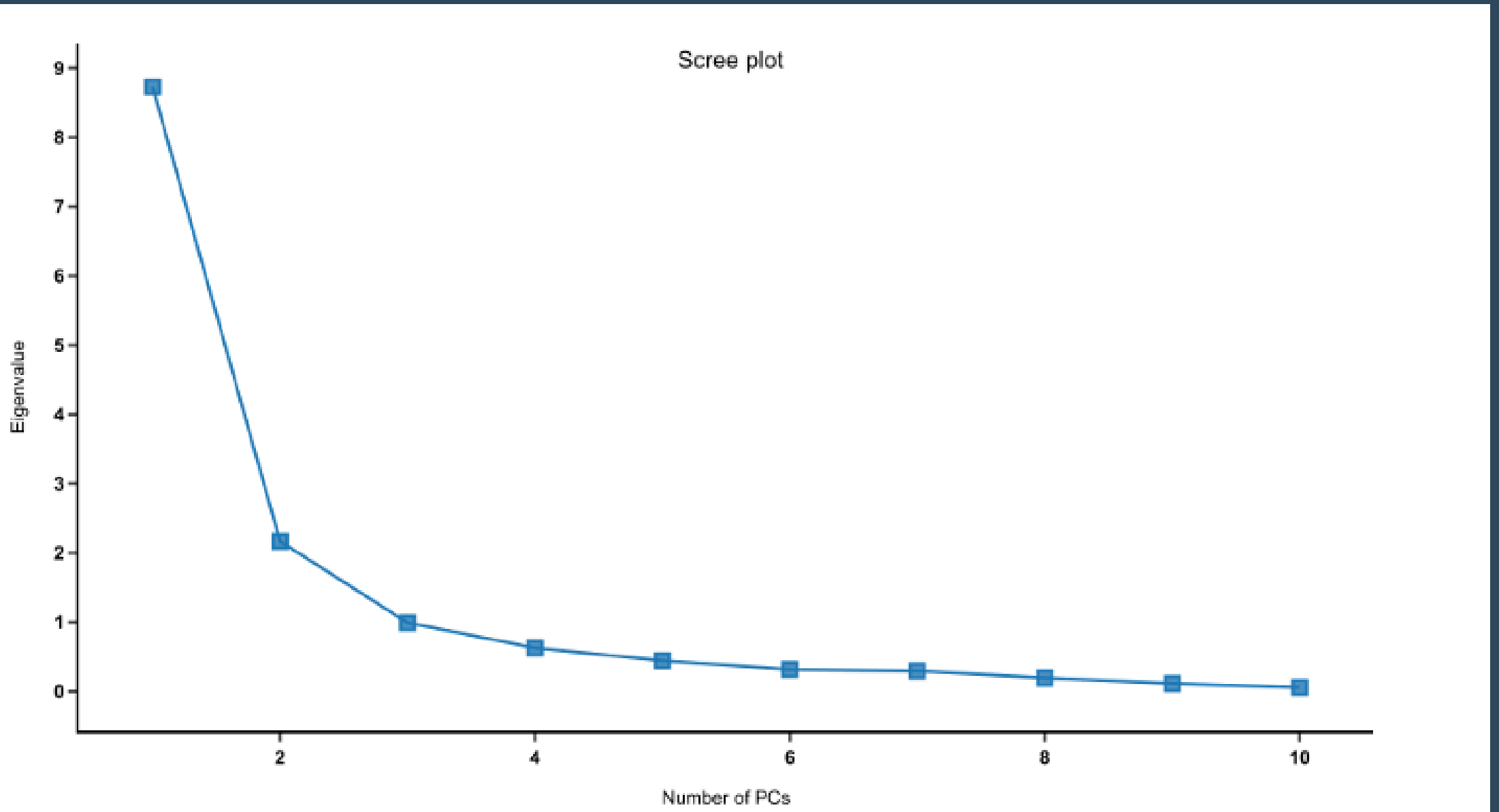
- ✓Any individual factor should account for the variance of at least single variable if it is to be retained for analysis
- ✓Factors with eigen value > 1 are selected
- ✓Reliable when the number of variable are in between 20-50.
- ✓Weakness – usually – usually recommends retaining an excessive number of factors (Ruiz & San Martin, 1992)

Percentage of cumulative variance extracted criterion

- ✓Natural sciences – 90 %
- ✓Social sciences – 60 %

Screen plot criterion (<20)

The point at which the curve begins to straighten out indicates the maximum number of factors


Scree plot
Eigenvalue
9
8
7
6
5
4
3
2
1
0
2
4
6
8
10
Number of PCs

Interpreting the factors

- Step1 : Examine the factors matrix of loading
  - PCA(Orthogonal) – Rotated component matrix
  - PROMAX (Oblique) – Pattern Matrix (EFA)
- Step 2 : Identify significant loading(s) for each factor
  - Method 1 : Practical significance

✓ Factors loading should not exceed 1

- Method 2: Statistical significance

To achieve a power level of 80 per cent at 5% level of significance, the following sample size are necessary to achieve desirable significance.

Factor loading	Interpretation in terms of practical significance
0.30	350
0.40	250
0.45	200
0.50	120
0.55	100
0.60	85
0.65	70

Step 3. Asses the commonalities of the variable

If variable is found not significantly loaded on identified factors, examine the commonalities.

When variables commonality falls below 0.50, it may be deleted. But (Cronbach >0.70- retain)

Step 4. Respecify the factors model if needed

Problems in factors analysis

- ✓A variable has no significant loadings
- ✓Even with significant loading, the commonalities are low (< 0.50)

Remedies

- ✓Ignore the problematic variables
- ✓Employ an alternative rotation method
- ✓Decrease or increase the factors reattained
- ✓Modify the type of factor model used

- Step 5 : Label the factors

Examine all the significant variables for a particular factor and assign a name or label for the factor that accurately reflects the nature of variables loading on thar factor.

- Stage6 : Validation of factor analysis

Confirmatory analysis

✓ Validate the model using a split or a separate sample

✓Confirmatory factor analysis through structural equation modeling – SPSS AMOS

Assessing factor's structure stability

✓Factors stability – Depends on sample size (Large sample gives stable factor structure) and the number of cases per variables (Minimum five)

✓Split the sample and validate the factor structure in the validation sample

Demonstration

Confirmatory Factor Analysis

- Difference between EFA and CFA

✓ In EFA, the data determines the factor structure

  ✓Statistical objective – Exact variance

  ✓EFA will give input to CFA

✓In CFA, a theoretical factor structure is specified and tested for its fit with the observed covariance among the item in the factors

  ✓Statistical objective – reproduce covariance matrix

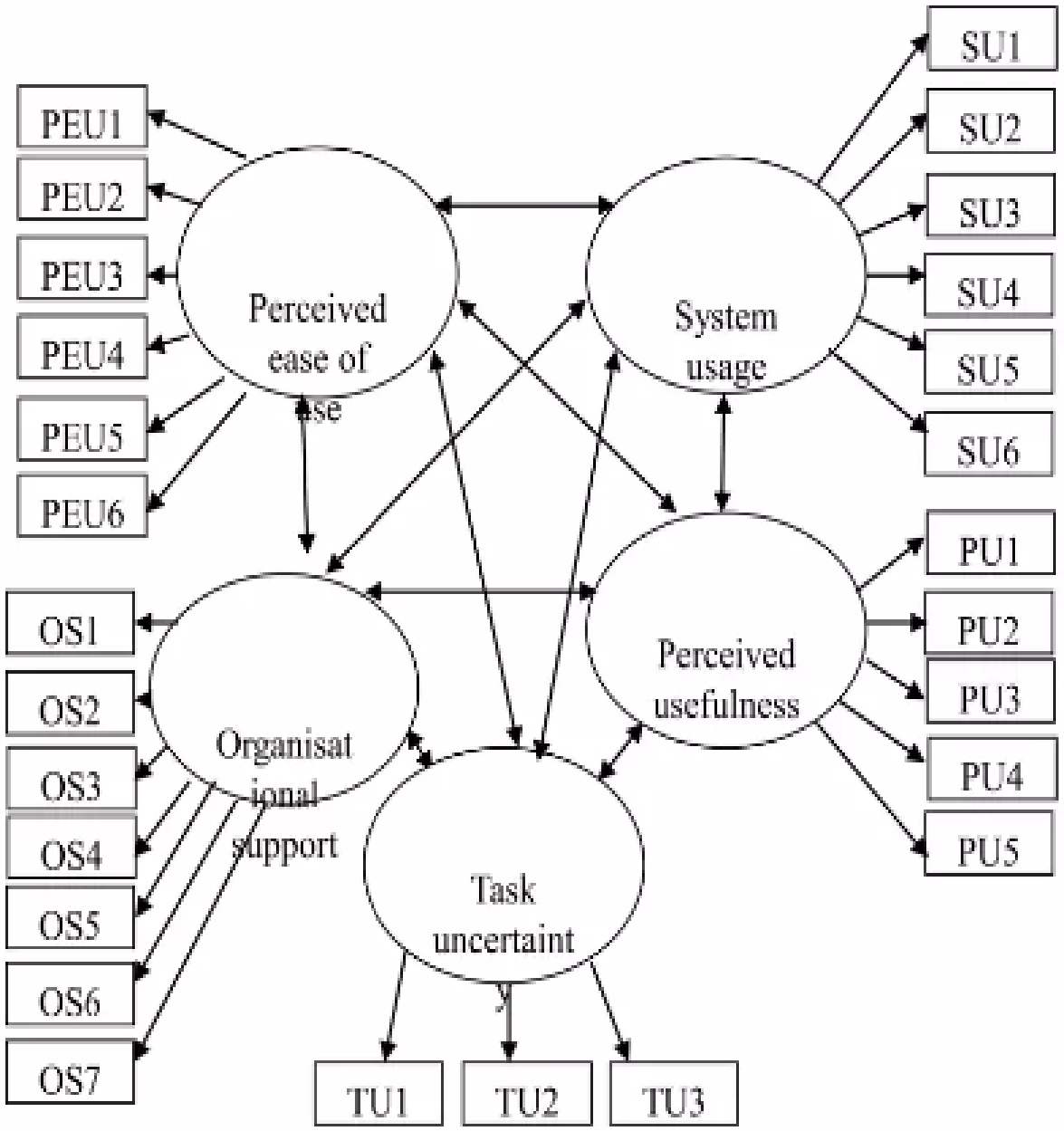
Computer programmes used for SEM estimation

Software available for SEM

- AMOS (Analysis of Moment Structure)
- LISREL (Liner Structural Relationships)
- SAS- PROC CALIS (Covariance Analysis and Linear structural Equations)
- EQS (Equations)
- R

AMOS

- Easy to use program for visual SEM
- Helps to quickly specify, view and modify the model graphically using simple drawing tools
- Prints a high-quality image of final model

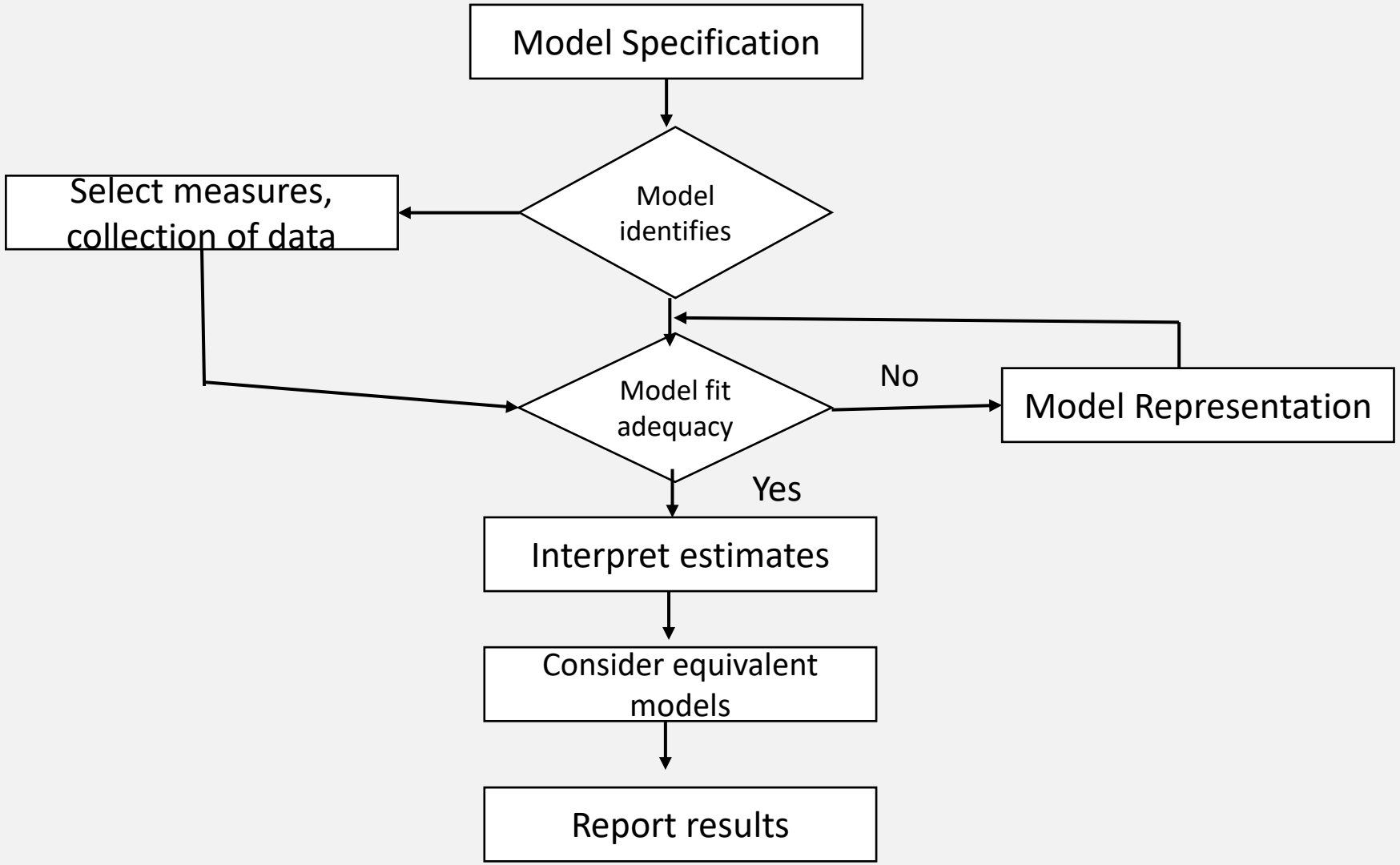


Developing and specifying measurement model

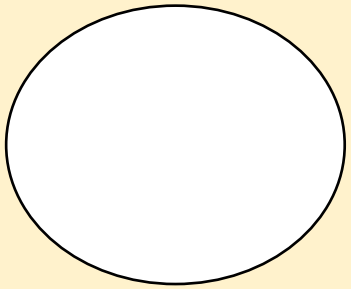
Measurement model is specified based on

- Measurement relationship between items and constructs
- Correlation relationships among constructs
- Error terms for the constructs

Steps in Confirmatory Factor Analysis



Basic elements of CFA- SEM



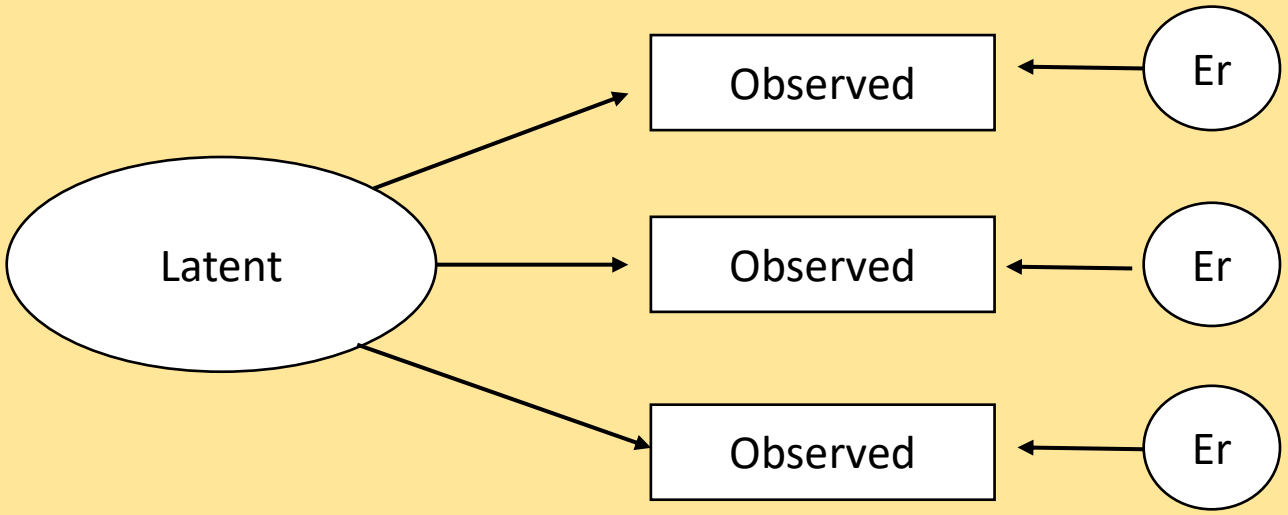
Latent construct or unobserved variable

Direction of influence

Observed variable or item or indicator

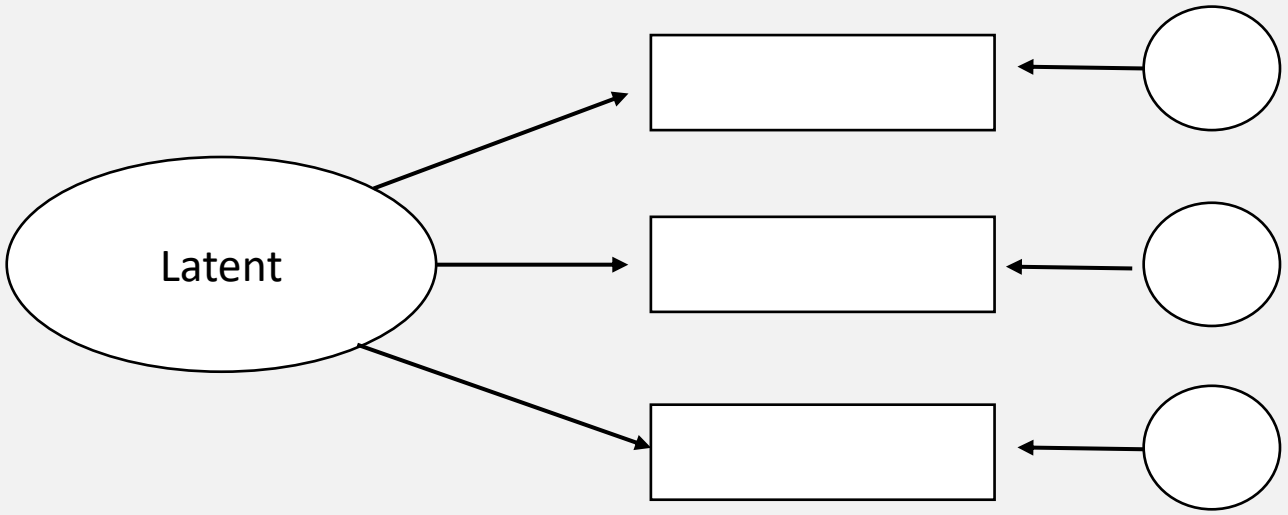
Co variance between two latent construct

Latent or unobserved constructs / variables or factors



- Can't be measured directly, measured by one or two indicators
- Operationally defined in terms of behaviour believed to represent it (e.g.: Consumers attitude towards GM crops
- Depicted as circle or eclipse in SEM

Measured or observed or manifest variable

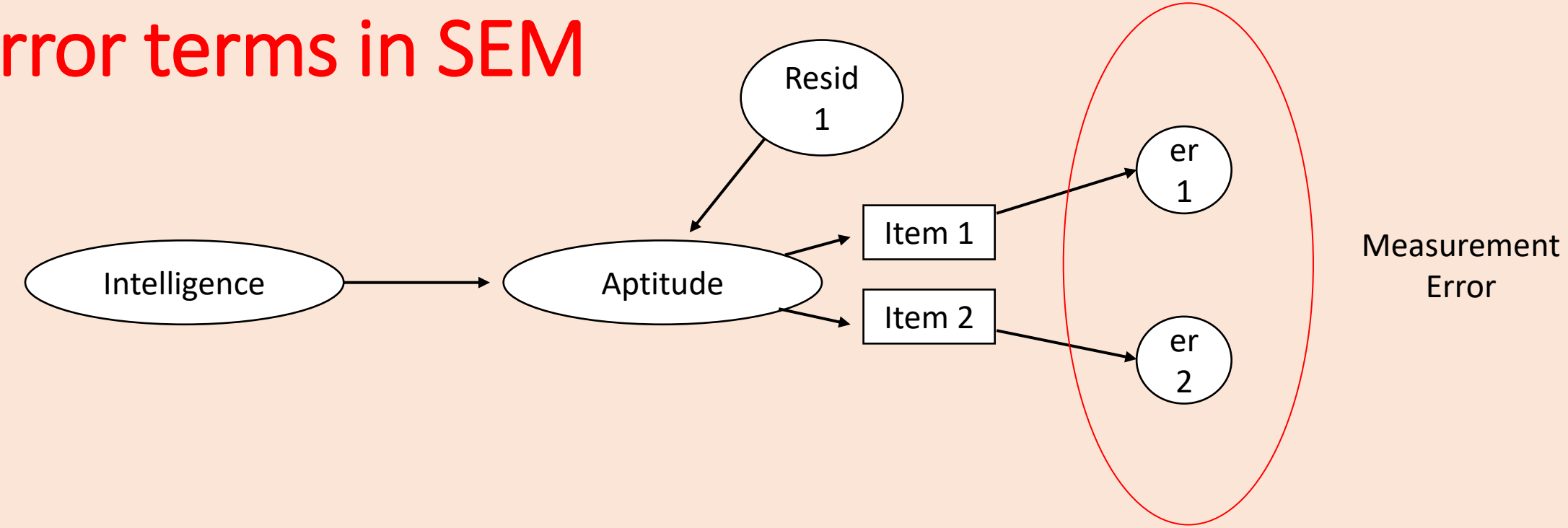


- Observed value of an item or questions
- Can be used as indicators of latent variable

(e.g. An attitude statement in a scale)

- Depicts as square or rectangle in SEM

Error terms in SEM



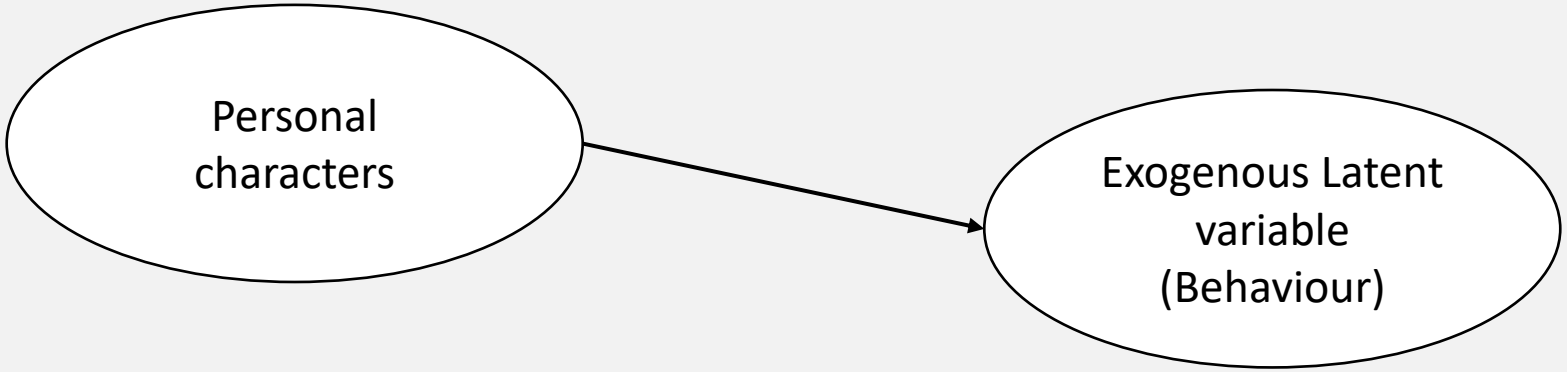
A: Measurement error

- Degree to which the variables we can measure do not perfectly describe the respective latent construct
- Associate with observed or indicator variables

B: Residual

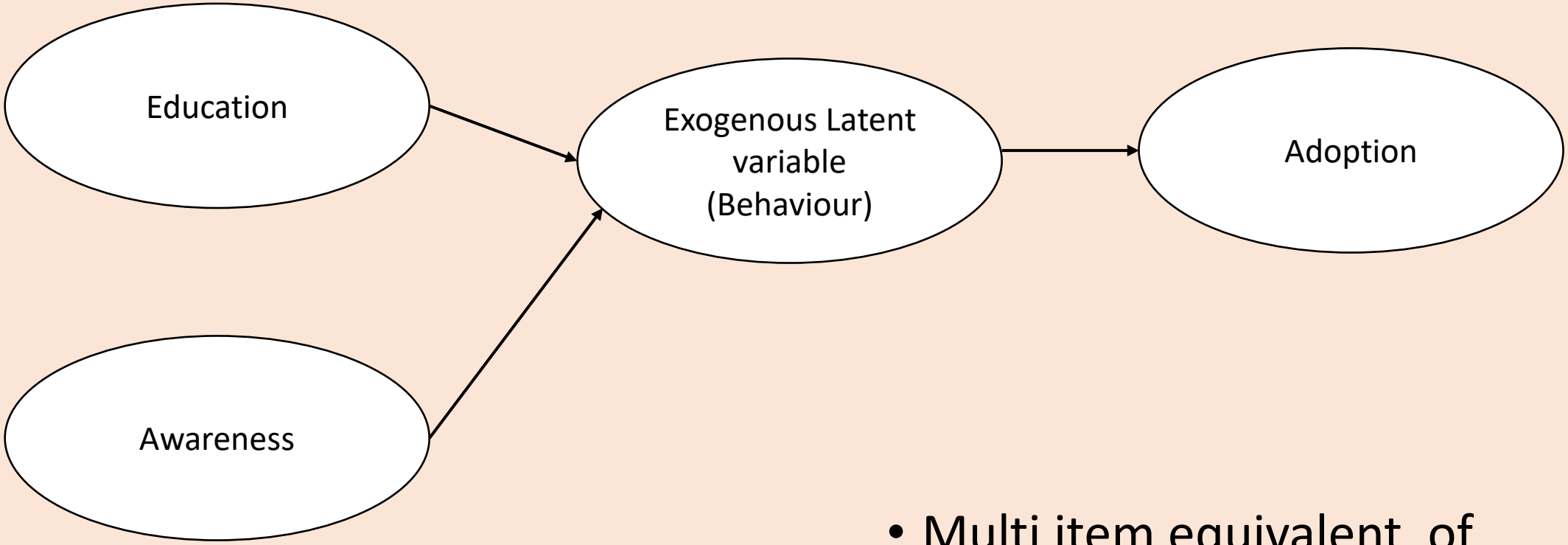
- Error in prediction of endogenous variable from exogeneous variables
- Bias – affects average score

Exogeneous variable



- Can be influenced by external factors like age, education, annual income etc.

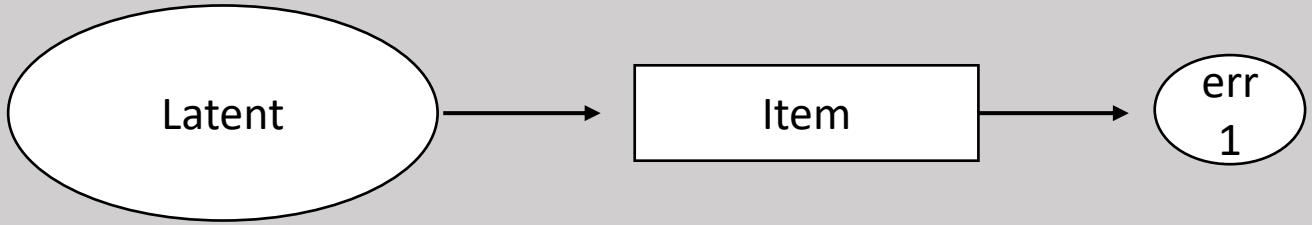
Endogenous variable



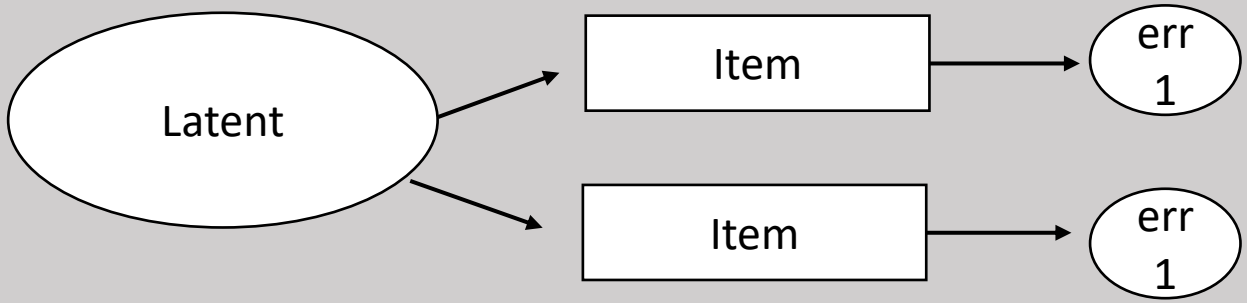
- Multi item equivalent of dependent variable

Depicting relationships in SEM

A. Relationship between a constructs and a observed variable

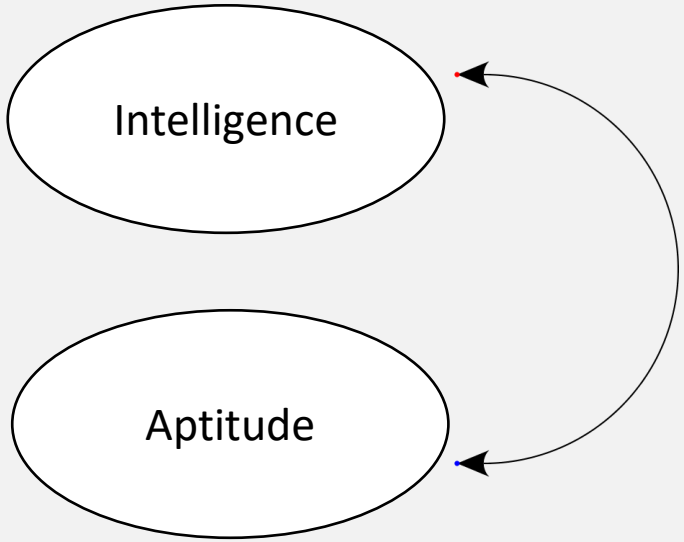


B. Relationship between a construct and multiple observed variables



C. Dependence relationship between two construction – A structural equation

D. Correlation relationship between two constructs (Covariance)



Minimum Sample size

Number of constructs	No of items / constructs	Minimum sample size
Five or less	>3	100
Seven or less	>3	150
Large number of constructs (>7)	<3	500

Choosing Estimation Method

Estimation technique: Mathematical algorithm that will be used to identify estimates for each free parameter

a. Maximum likelihood method

- Provides " most likely" parameters values to achieve best fit for model
- Sensitive to multivariate normality

b. Weighted least square

c. Generalized least squares

d. Asymptotically distribution free (ADF)

- Intensive to non- normality
- Require large sample

What does CFA Actually test?

Does our hypothesized factor structed be confirmed ?

Two criteria and outputs

Goodness of fit (Model fit)- Is the observed covariance matrix is similar to estimated covariance matrix?

Validity and reliability of measurement model?- trough regression

Goodness-of-fit measures

- Absolutes fit- Measures the degree to which the proposed model predicts the observed covariance
- Incremental fit: Compare the proposed model to a realistic null or baseline model
- Parsimonious fit: Diagnoses whether model fit is due to over fitting the data with too many coefficients
- Predictive fit: Assess model fit in hypothetical replication sample of the same size and randomly drawn from the same population

Goodness - of - fit indices

Absolute fit indices

Model Chi-square

- Ideal value – *non-significant chi- square*
- Increases with sample size
- Sensitive to multivariate normality

Normed chi-square

- Model chi-squares values / degrees of freedom
- Used in place of model chi-square if the data deviate from normality
- Ideal value - < 3 (Hair et al , 1998) for sample size below 750

Goodness - of - Fit Index (GFI)

- Value ranges from 0 to 1 ; Ideal value > 0.90 (Hair et al., 1998)

Root Mean Square Error of Approximation (RMSEA)

- Ideal value – 0.05 – 0.08 (Browne & Cudeck, 1993)

Root Mean Square Residual (RMR)

- Ideal value –RMR - < 0.05 ; SRMR < 0.10 (Hair et al , 1998)

Goodness- of – fit indices

Incremental fit indices

Normal fit index (NFI)

- Value range from 0 to 1; ideal value - >0.90 (Hair et al., 1998)

Tucker Lewis index (TLI)

- Values range from 0 to 1 : ideal value – Higher values close to one (Hair et al , 1998)

Comparative fit index (CFI)

- Widely used due to insensitive to model complexity
- Values range from 0 to 1; ideal value > 0.90 (Hair et al , 1998)

Goodness - of - fit indices

Parsimony fit indices

Adjusted Goodness of fit Index (AGFI)

- Values range from 0 to 1 ; ideal value close to one (Hair et al , 1998)

Parsimony Normed fit Index (PNFI)

- Sample- based, parsimony-adjusted, sensitive to model size
- Ideal value – Higher values close to one (Kelloway, 1998)

Goodness – of – fit indices

Predictive fit indices

Akaike information criterion (AIC) & Consistent AIC Criterion (CAIC)

- Used to select among competing nonhierarchical models estimated with me the same data
- Model with smaller AIC and CAIC are chosen (Hu & Bentler, 1995)

Expected cross validation index (ECVI)

- To asses the likelihood that the model cross-validates across similar sized samples from the same population
- Model having the smallest ECVI value is selected

Convergent Validity – From Estimates

Convergent validity

Extent to which indicators of a specific construct converge or share a high proportion of variance in common

(i) Standardized regression coefficient

- Used as a measure of validity of each indicator variable (λ) path significance indicating the effect of one variable on other variable (β)
- Ideal value – $\lambda > 0.6$ (Bollen, 1989)

(ii) Item correlation

- Item –to – total correlation > 0.50; Inter-item correlation

Composite reliability

Squared multiple correlation > 0.50 (Bagozzi and Yi 1988)

Demonstration

Advantages

- Validity
- Reliability
- Low Measurement Error
- Complex Concept Models
- Confirmatory Approach

Model Identification

Parameter Identification

Estimation methods & problem

Sample size and distribution

Interpretation of results

Challenges &Potential Problems

Literature review

Using structural equation modeling to predict Indian people's attitudes and intentions towards COVID-19 vaccination

Hilal *et al*

2021

Methodology

- Sample 300
- SPSS and AMOS we used
- Seven constructs: Perceived (3), Risk perception (3), Media exposure (3 Social media), Social norms (3), Trust, Attitude (4), Intensions (4).

Results

	Estimates	SE	CR	P	Decision
PB -> ATT	0.344	0.071	4.878	***	Supported
RP -> ATT	0.054	0.037	1.462	0.144	Not Supported
SN -> ATT	0.115	0.047	2.441	*	Supported
ME -> ATT	0.083	0.053	1.570	0.116	Not Supported
TR -> ATT	0.202	0.055	3.641	***	Supported
SN -> INT	0.157	0.054	2.916	**	Supported
ME-> INT	0.066	0.060	1.107	0.269	Not Supported
TR -> INT	0.286	0.066	4.301	***	Supported
ATT -> INT	0.526	0.088	5.977	***	Supported
PB = Perceived benefits, RP= Risk perception, ME= Media exposure , Social norms					

- Paul, J.M., Jasim., K. M., Devi, M. N. and Karthikeyam,C. 2020. Data analysis in Agricultural Extension Research. (e-Book). Vivekanandha International Book Publishers. ISBN:978-81-95695-25-6.
- Barbara, M.B. 2010 . Structure Equation Modeling with AMOS- Basic concepts, Applications and programming. Taylor and Francis Group, LLC, New York.

Understanding Farmers' Intention to Use a Sustainability Standard: The Role of Economic Rewards, Knowledge, and Ease of Use

Veronika and Johannes (2021)

Methodology

Structure equation modeling

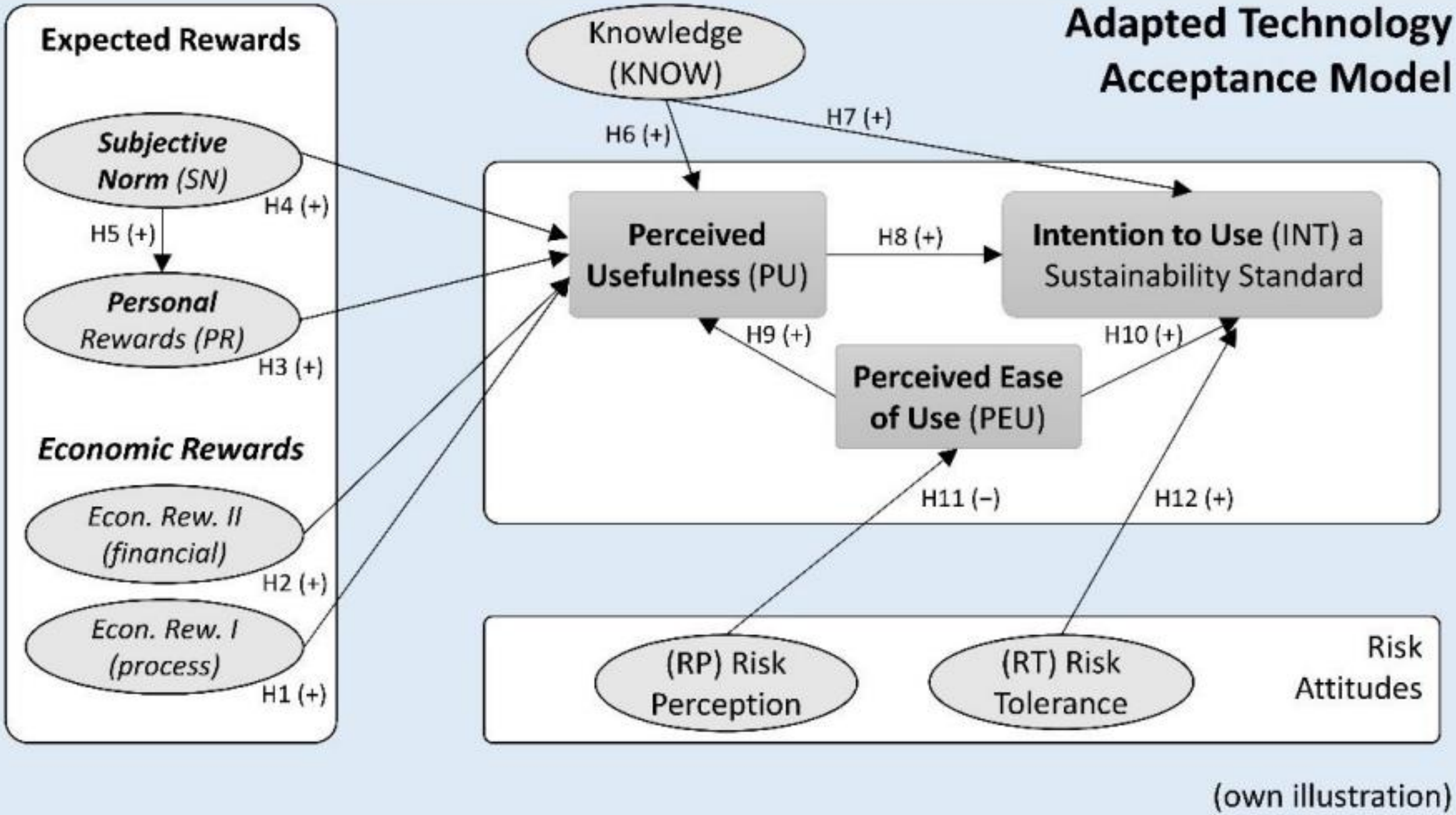
Data collected from 598 farmers

Questionnaire

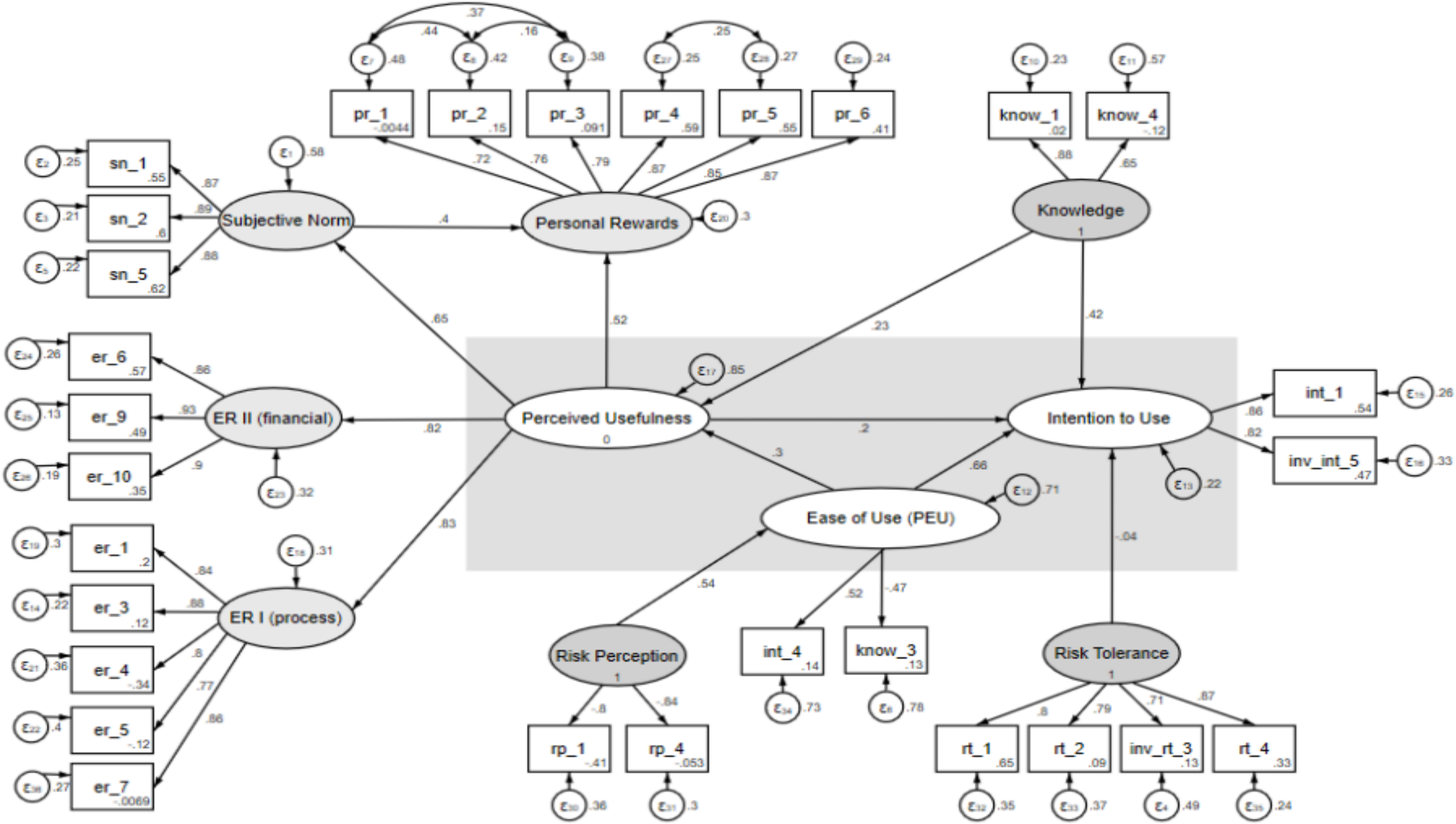
EFA

CFA

12 hypothesis is developed based on review



(own illustration)


pr_1
pr_2
pr_3
pr_4
pr_5
pr_6
sn_1
sn_2
sn_5
Subjective Norm
Personal Rewards
know_1
know_4
Knowledge
er_6
er_9
er_10
ER II (financial)
er_1
er_3
er_4
er_5
er_7
ER I (process)
Perceived Usefulness
Ease of Use (PEU)
Intention to Use
int_1
inv_int_5
int_4
know_3
Risk Perception
rp_1
rp_4
Risk Tolerance
rt_1
rt_2
inv_rt_3
rt_4

Results

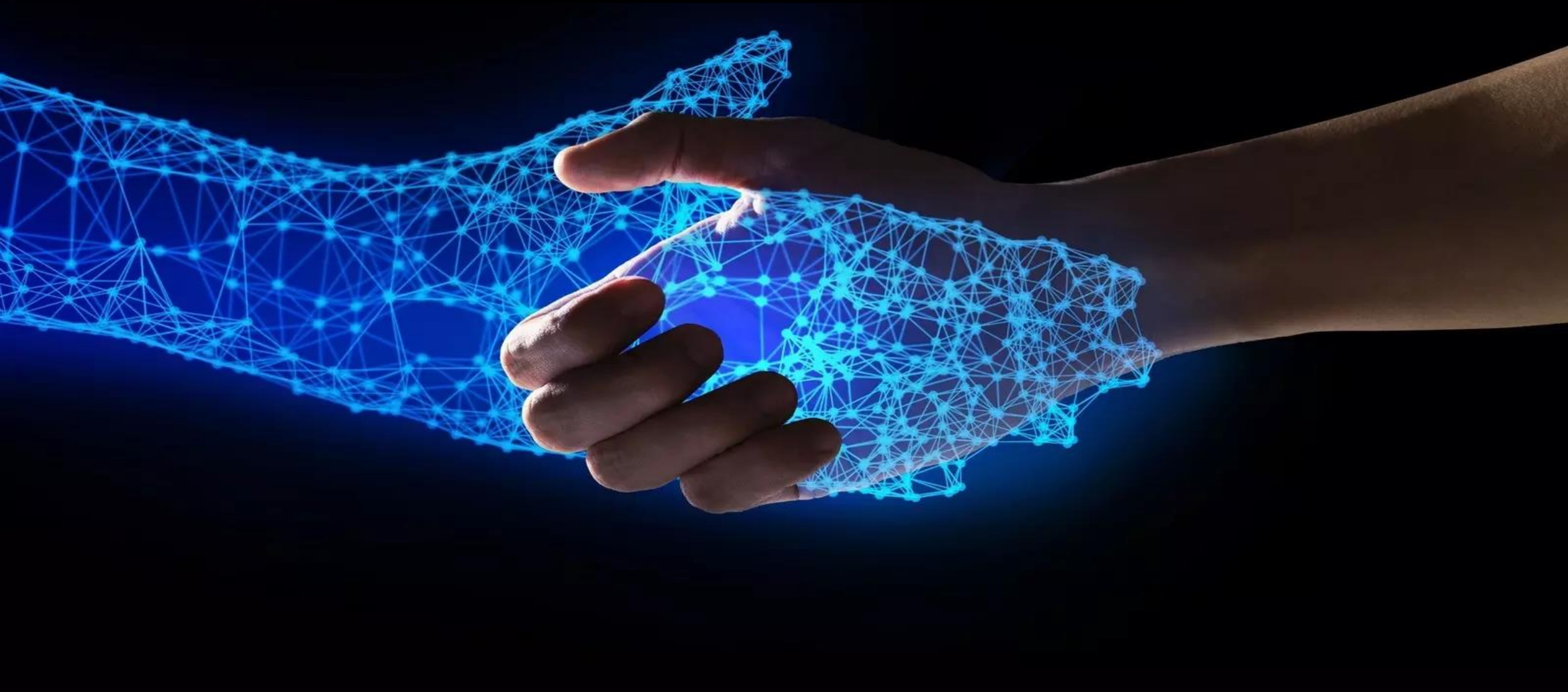
Latent construct	Path[1]	Loading[2]	SE[3]	Hypothesis	R^2
SN (Subjective Norm)	-> PU ®	0.646***	0.0528	H4	0.417
PR (personal reward)	<- SN (f) -> PU (r)	0.399*** 0.524***	0.0573 0.121	H5 H3	0.705
ER I(Economic reward – process optimization)	-> PU (r)	0.833***	0.0312	H1	0.694
ER II(Improved technology)	-> PU (r)	0.824***	0.0368	H2	0.679
PU (Perceived usefulness)	<- Know (f) <- PEU (f)	0.233*** 0.305***	0.0656 0.103	H6 H9	0.146
INT (Intension to use)	<- PU (f) <- PEU (f) <- Know (f) <-RT (f)	0.195** 0.663*** 0.427*** -0.040	0.0868 0.0716 0.0530 0.0472	H8 H10 H7 H12	0.777
PEU (Ease of use)	<- RP (f)	0.537***	0.0775	H11	0.288

Paths: f= Formative measurement, r= reflective measurement. SE= Standard error, Significance level * 10%, ** 5%, *** 1 %.

Recommended Reading

- Kline, R. B. (1998). Principles and practice of structural equation modeling. New York: Guilford. (accessible, up-to-date introduction to structural equation modeling; the current second edition (2005) generally is as easily accessible as the first, but more oriented towards the AMOS software, while the first edition is more oriented towards LISREL; in addition, the first also offers a bit more detail in certain areas)
- Bollen, K. A. (1989). Structural equation modeling with latent variables (2nd ed.). New York: Wiley. (still one of the most comprehensive sources on structural equation modeling)

Conclusion




Let us discuss
questions, ideas
and opinions
plan
passion
imagination
ingenuity
NEGATIVE
POSITIVE