RESEARCH METHODS

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Topic 10

Developing Instrument: Identifying Variables
Why Measure?

★ Measurement = assigning numbers to empirical events, objects, properties or activities in compliance with a set of rules.

★ Some reasons:
  - evaluate an explanation
  - test a hypothesis
  - provide empirical support for a theory
  - make a decision about phenomenon of study

★ More relevant to quantitative research than qualitative research.

★ What is measured – variables of study
  - conceptual definition
  - operational definition = defines a variables based on a specific measurement and testing criteria
Conceptualization & operationalization of abstract construct to concrete measure

**Independent Variable**

- Abstract Construct
  - Conceptualization
    - Conceptual definition
    - Operationalization
  - Indicator or Measure

- Tested Empirical Hypothesis

**Dependent Variable**

- Abstract Construct
  - Conceptualization
    - Conceptual definition
    - Operationalization
  - Indicator or Measure

- Theoretical level
- Operational level
- Empirical level

*(Neuman, 2009)*
How to Create Good Measures: Reliability and Validity

Figure: Illustration of relationship between reliability and validity

(Adapted from Babbie, 2004)
# What is Variable?

<table>
<thead>
<tr>
<th>Authors</th>
<th>Definitions of Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kumar, 2011</td>
<td>A concept that can be measured on any one of the four types of measurement scale, which have varying degrees of precision in measurement.</td>
</tr>
<tr>
<td>Kumar, 2005</td>
<td>A concept that can be measured.</td>
</tr>
<tr>
<td>Kerlinger, 1986</td>
<td>A property that can take on different value. -A symbol to which numerals or values are attached.</td>
</tr>
<tr>
<td>Black &amp; Champion, 1976</td>
<td>A rational units of analysis that can assume any one of a number of designated sets of values.</td>
</tr>
</tbody>
</table>
**Concept vs Variable**

**Concept**
- Mental images or perception
- Cannot be measured
- Subjective impression

**Variable**
- Measureable, though.
- Subjected to measurement by crude/refine or subjective/objective units of measurement.

### Differences between a Concept and a Variable

<table>
<thead>
<tr>
<th>Concept</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>Example:</td>
</tr>
<tr>
<td>• Effectiveness</td>
<td>• Gender (male/female)</td>
</tr>
<tr>
<td>• Satisfaction</td>
<td>• Attitude</td>
</tr>
<tr>
<td>• Excellent</td>
<td>• Age</td>
</tr>
<tr>
<td>• Domestic violence</td>
<td>• Income (RM___ per year)</td>
</tr>
</tbody>
</table>
Converting concepts into variables

- Concepts are subjective impressions which, if measured as such would cause problems in comparing responses obtained from different respondents.
- Therefore, it is important for the concepts to be converted into variables as they can be subjected to measurement.

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Indicators</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rich</td>
<td>1. Income</td>
<td>1. Income / year</td>
</tr>
<tr>
<td></td>
<td>2. Assets</td>
<td>2. Total value of: home; car; investment</td>
</tr>
<tr>
<td>High academic</td>
<td>1. Average marks obtained in examinations</td>
<td>1. Percentage of marks</td>
</tr>
<tr>
<td>achievement</td>
<td>2. Average marks obtained in practical work</td>
<td>2. Percentage of marks</td>
</tr>
<tr>
<td></td>
<td>3. Aggregate marks, etc.</td>
<td>3. Percentage of marks</td>
</tr>
</tbody>
</table>
TYPES OF VARIABLE

Causal Model

- Independent Variables
  - Change variables.
  - The cause.

- Intervening Variables
  - Variables that link a cause-and-effect relationship.

- Extraneous Variables
  - Unmeasured variables affecting the cause-and-effect relationship.

- Dependent Variables
  - Outcome/effect/endogenous variables.

Study design

Unit of measurement
TYPES OF VARIABLE

**Independent Variable (IV)**
- The variables that is responsible for bringing about change in a phenomenon/situation.
- Known as predictor, exogenous variable.

**Dependent Variable (DV)**
- The outcome of the change brought about by the IV.
- Known as outcome, endogenous variable.
How Variables are Measured

• Objective data
  – e.g. weight, absenteeism, temperature
    • Use appropriate measuring instruments

• Subjective data
  – e.g. feelings, attitudes, perceptions
    • Operationalise the concept
Measurement Scale of the Variable

- **Nominal**
- **Ordinal**
- **Interval**
- **Ratio**

- Categorical variable
  - Dichotomous (2 categories)
  - Polytomous (>2 categories)

- Continuous variable
  - Have continuity in the measurement
Nominal Scale

- Splits data into mutually exclusive and collectively exhaustive categories

- E.g. Male / female, up / down, rich / poor
Ordinal Scale

- Ranks data in some order
- E.g. exercising for 20 minutes is good, for 30 minutes is better, for 40 minutes is best.
Interval Scale

- Sets data on a continuum

Very low

1 2 3 4 5 6 7 8

Very high
Ratio Scale

- Starts with absolute zero and indicates proportion

Ten is twice as big as five
### Properties of Measurement Scales

<table>
<thead>
<tr>
<th>Scale</th>
<th>Difference</th>
<th>Order</th>
<th>Distance</th>
<th>Unique origin</th>
<th>Measures of central tendency</th>
<th>Measures of dispersion</th>
<th>Some tests of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Mode</td>
<td>—</td>
<td>$X^2$</td>
</tr>
<tr>
<td>Ordinal</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Median</td>
<td>Semi-interquartile range</td>
<td>Rank-order correlations</td>
</tr>
<tr>
<td>Interval</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Arithmetic mean</td>
<td>Standard deviation, variance, coefficient of variation</td>
<td>$t, F$</td>
</tr>
<tr>
<td>Ratio</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Arithmetic or geometric mean</td>
<td>Standard deviation, variance or coefficient of variation</td>
<td>$t, F$</td>
</tr>
</tbody>
</table>

**Note:** The interval scale has 1 as an arbitrary starting point. The ratio scale has the natural origin 0, which is meaningful.
The Format / Rating Scale

- **Scale** = A measure that captures the intensity of a person’s behaviors or feelings.

- **Commonly used scales:**
  - **Likert scale** – most frequently used
  - **Semantic differential** – measures meaning or attitude on a series of scales anchored at each extreme by bipolar adjectives
  - **Simple categorical scale**
**SECTION D: CONSCIENTIOUSNESS**

This section contains FOUR (4) questions on your personality. Please **circle** the most accurate answer based on the following scale.

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>Once in a while</th>
<th>Sometimes</th>
<th>Fairly often</th>
<th>Frequently, if not always</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

1. Get chores done right away.  
2. Often forget to put things back in their proper place. (R)  
3. Like order.  
4. Make a mess of things. (R)
Semantic Differential Example

Responsive __ ___ ___ ___ ___ ___ ___ ___ Unresponsive

Good __ ___ ___ ___ ___ ___ ___ Bad

Courageous __ ___ ___ ___ ___ ___ ___ Timid

Simple Categorical Scale Example

Do you own a house?  □ Yes □ No

Gender  □ Male □ Female
Instrument Development: Questionnaire

• A questionnaire = a pre-formulated written set of questions to which respondents record their answers, usually within closely defined alternatives.

• Questionnaire should be clear, easy to read & pleasant to the eyes.

• Sequence of question should be easy to follow.
## Ways of Administering Questionnaire

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mailed Questionnaire</td>
<td>• Send Q to respondent by mail.</td>
</tr>
<tr>
<td></td>
<td>• Major problem: low response rate.</td>
</tr>
<tr>
<td>Collective/group administered</td>
<td>• Administer to a group of respondent.</td>
</tr>
<tr>
<td></td>
<td>• e.g. student in classroom</td>
</tr>
<tr>
<td></td>
<td>• After responding can immediately collect the Q.</td>
</tr>
<tr>
<td></td>
<td>• High response rate.</td>
</tr>
<tr>
<td>Administration in public area</td>
<td>• Administer Q at shopping complex, hospital etc.</td>
</tr>
<tr>
<td>Phone interview</td>
<td>• Call respondent.</td>
</tr>
<tr>
<td></td>
<td>• Researcher ask question – respondent respond.</td>
</tr>
<tr>
<td>Others</td>
<td>• Email, internet, fax</td>
</tr>
</tbody>
</table>
**Business Research Class Questionnaire**

The purpose of this short questionnaire is to collect some nominal, ordinal, interval and ratio data that can be used to demonstrate some of the basic statistical methods for analysing quantitative data. The individual responses will be anonymous and the data collected will be used only for class exercises.

Please tick the appropriate box, provide the data requested or circle a number, where appropriate.

1. What is your gender?
   - Female ☐
   - Male ☐

2. Please indicate your height to the nearest centimetre (cm)  ____

3. Please indicate your weight to the nearest kilogram (kg)  ____

4. What is the colour of your eyes? (just tick one box please!)
   - Blue ☐
   - Brown ☐
   - Other ☐

5. Please indicate the extent to which you disagree or agree with the following statements:

<table>
<thead>
<tr>
<th>Statistics is interesting.</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Statistics knowledge is useful in business.</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Many thanks for your time and assistance with completing this questionnaire. We will now proceed to analyse the data collected!
## Advantages of Questionnaires & Interview

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less expensive</td>
<td>More appropriate for complex situations</td>
</tr>
<tr>
<td>Offers greater anonymity</td>
<td>Useful for collecting in-depth information</td>
</tr>
<tr>
<td>Helps a researcher or manager obtain data fairly easily</td>
<td>Information can be supplemented</td>
</tr>
<tr>
<td>Information from questionnaires is easily coded</td>
<td>Questions can be explained</td>
</tr>
<tr>
<td>Benefits the scientific community if the measures are well validated and reliable</td>
<td>Has a wider application</td>
</tr>
</tbody>
</table>
## Disadvantages of Questionnaires & Interview

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application is limited</td>
<td>Time consuming &amp; expensive</td>
</tr>
<tr>
<td>Response rate is low</td>
<td>Quality of data depends upon the quality of the interaction</td>
</tr>
<tr>
<td>Self-selecting bias</td>
<td></td>
</tr>
<tr>
<td>Opportunity to clarify issues is lacking</td>
<td>Quality of data depends upon the quality of the interviewer</td>
</tr>
<tr>
<td>Spontaneous responses are not allowed for</td>
<td></td>
</tr>
<tr>
<td>Response to a question may be influenced by the response to other question</td>
<td>Quality of data may vary when many interviewers are used</td>
</tr>
<tr>
<td>Possible to consult others</td>
<td>The researcher may introduce his/her bias</td>
</tr>
<tr>
<td>A response cannot be supplemented with other information</td>
<td></td>
</tr>
</tbody>
</table>
Impact of Other Aspects of a Survey on Questionnaire Design
**Forms of question**

- **Open ended** – possible response are not given
- **Close ended** – possible answers are given in Q

**How to look for instrument**

Look for instrument in Journals:

- Research / empirical paper
  - [look for: Measures/instrument/variable section]
- Papers on scale or instrument development/construction
Criteria for Choosing a Good Instrument

• Have authors developed the instrument recently?
• Is the instrument widely cited by other authors?
• Are reviews available for the instrument?
• Does the procedure for recording data fit the research questions / hypotheses in your study?
• Does the instrument contain accepted scales of measurement?
• Is there information about the reliability & validity of scores from past uses of the instrument?
Goodness of Measures

Reliability measures (accuracy in measurement)
- Stability
  - Test–retest reliability
  - Parallel-form reliability
  - Inter-item consistency reliability
  - Split-half reliability
- Internal consistency

Validity measures (are we measuring the right thing?)
- Face validity
- Content validity
- Criterion-related validity
  - Predictive
  - Concurrent
- Construct validity
  - Convergent
  - Discriminant
**VALIDITY:** The degree to which the researcher has measured what it is designed to measure.

- The extent to which an empirical measure adequately reflect the real meaning of the concepts under consideration (Babbie, 1989).

**Types of Validity**

- **Face and content**
  Representative of all possible questions that could be asked

- **Criterion**
  Scores as a predictor of an outcome / criterion they are expected to predict

- **Construct**
  Determination of the significance, meaning, purpose, and use of the scores
Face and Content Validity

**Face validity**
Subjective agreement among professionals that the scale logically appears to reflect accurately what it intends to measure.

**Content validity**
Ensure items and questions cover the full range of the issue/variable to be measured.
Criterion Validity

**Predictive validity**
The degree of the instrument can forecast an outcome. Test scores are collected first, then a later time the criterion measure is collected.

**Concurrent validity**
How well an instrument compares with a second assessment concurrently done. Calculate the concurrent validity by correlating the scores.
Construct Validity

- Assess whether the scores from an instrument contributes to the total variance observed in a phenomena (variables) or construct of study.

- The greater the variance attributable to the construct the higher the validity of the instrument.

- Use statistical technique – Factor Analysis.
**Stability**

- Refers to the ability of a measure to maintain stability over time, despite uncontrollable testing conditions or the state of the respondents themselves.

- Types:
  - Test-retest reliability
  - Parallel-form reliability

**Internal consistency**

- Indicates how well the items ‘hang together as a set’ and can independently measure the same concept, so respondents attach the same overall meaning to each of the items.

- Types:
  - Inter-item consistency reliability
  - Split-half reliability
Stability of Measures

• **Test-retest reliability**
  – the reliability coefficient obtained with a repetition of the same measure on a second occasion

• **Parallel-form reliability**
  – the correlation obtained from responses on two comparable sets of measures (changed for wording & question order) tapping the same construct
Internal Consistency of Measures

- **Inter-item consistency reliability**
  - test of the consistency of respondents’ answers to all the items in a measure
  - usually tested by *Cronbach’s coefficient alpha*

- **Split-half reliability**
  - reflects the correlations between two halves of an instrument