Topic: Identifying Variables in Research

Aims and Objectives: What is a variable? What variables and concepts are and how they are different, How to turn concepts into operational variables, Types of variables from the viewpoint of: causation, study design and unit of measurement.

1.0 Introduction

Whether we accept it or not, we all make value judgements constantly in our daily lives: 'This food is excellent'; 'I could not sleep well last night'; 'I do not like this'; and 'I think this is wonderful'. These are all judgements based upon our own preferences, indicators or assessment. Because these explain feelings or preferences, the basis on which they are made may vary markedly from person to person. There is no uniform yardstick with which to measure them. A particular food may be judged 'excellent' by one person but 'awful' by another, and something else could be wonderful to one person but ugly to another. When people express these feelings or preferences, they do so on the basis of certain criteria in their minds, or in relation to their expectations. If you were to question them you will discover that their judgement is based upon indicators and/or expectations that lead them to conclude and express a particular opinion.

These are not preferences; these are judgements that require a sound basis on which to proclaim. For example, if you want to find out if a programme is effective, if a service is of quality or if there is discrimination, you need to be careful that such judgements have a rational and sound basis. This warrants the use of a measuring mechanism and it is in the process of measurement that knowledge about variables plays an important role.

Variables can be defined as any aspect of a theory that can vary or change as part of the interaction within the theory. In other words, variables are anything can effect or change the results of a study. Every study has variables as these are needed in order to understand differences. Variable is a quantity or a characteristic that has or more mutually exclusive values or properties of objects or people that can be classified, measured or labeled in different ways.

However, there are some who believe that scientific methods are incapable of measuring feelings, preferences, values and sentiments, though there are situations where such feelings or judgements cannot be directly measured but can be measured indirectly through appropriate

indicators. These feelings and judgements are based upon observable behaviours in real life, though the extent to which the behaviours reflect their judgements may vary from person to person.

1.1 The difference between a concept and a variable

Measurability is the main difference between a concept and a variable. Concepts are mental images or perceptions and therefore their meanings vary markedly from individual to individual, whereas variables are measurable, though, of course, with varying degrees of accuracy. A concept cannot be measured whereas a variable can be subjected to measurement by crude/refined or subjective/objective units of measurement. Concepts are subjective impressions which, if measured as such would cause problems in comparing responses obtained from different respondents. An image, perception or concept that is capable of measurement - hence capable of taking on different values - is called a variable. In other words, a concept that can be measured is called a variable. A variable is a property that takes on different values. Putting it redundantly, a variable is something that varies ... A variable is a symbol to which numerals or values are attached' (Kerlinger, 1986).

Concepts are subjective impression, has No uniformity as to its understanding among different people, and as such cannot be measured. Example of concepts include: Effectiveness, satisfaction, impact, Excellence, Rich, Extent and pattern of alcohol consumption, Domestic violence, Self- esteem, High Achiever etc

Variable are measurable though the degree of precision varies from scale to scale and from variable to variable (eg. Attitude is subjective, income is objective). Example of variable include: Gender (male/Female), Height (metres), Weight (kg), Income, Age (years), Religion (Catholic, protestant, Pentecostal, Muslim, Attitude etc

1.1.2 Converting Concepts into Variables

If you are using a concept in your study, you need to consider its operationalisation - that is, how it will be measured. In most cases, to operationalise a concept you first need to go through the process of identifying indicators - a set of criteria reflective of the concept - which can then be converted into variables. The choice of indicators for a concept might vary with the researcher but those selected must have a logical link with the concept. Some concepts, such as 'rich' (in terms of wealth), can easily be converted into indicators and then variables. For example, to decide objectively if a person is 'rich', one first needs to decide upon the indicators

of wealth. Assume that we decide upon income and assets as the indicators. Income is also a variable since it can be measured in naira; therefore, you do not need to convert this into a variable. Although the assets owned by an individual are indicators of his/her 'richness', they still belong to the category of concepts. You need to look further at the indicators of assets. For example, house, boat, car and investments are indicators of assets. Converting the value of each one into naira will give the total value of the assets owned by a person. Next, fix a level, based upon available information on income distribution and an average level of assets owned by members of a community, which acts as the basis for classification. Then analyse the information on income and the total value of the assets to make a decision about whether the person should be classified as 'rich'. The operationalisation of other concepts, such as the 'effectiveness' or 'impact' of a programme, may prove more difficult.

Concepts	Indicators	Variables	Decision (Working Definitions)
Rich	Income	Income per year	< 250,000 ≥ 250,000
High Academic achievement	Average mark obtain in examination	Percentage marks	75% ≥ 80%

Table1. Converting Concepts to Variable

Concepts → Indicators → Variables

One of the main differences between quantitative and qualitative research studies is in the area of variables. In qualitative research, as it usually involves studying perceptions, beliefs, or feelings, you do not make any attempt to establish uniformity in them across respondents and hence measurements and variables do not carry much significance. On the other hand, in

quantitative studies, as the emphasis is on exploring commonalities in the study population, measurements and variables play an important role.

1.2 Types of Variables

i. Discrete Variable – only a finite or potentially countable set of values.

ii. Continuous Variable – an infinite set of values between any two levels of the variables. They are result of measurement.

iii. Independent Variable – a stimulus variable which is chosen by the researcher to determine its relationship to an observed phenomena.

iv. Dependent Variable – a response variable which is observed and measured to determine the effect of the independent variable.

v. Moderate Variable – a secondary or special type of independent variable chosen by the researcher to ascertain if it alters or modifies.

vi. Control Variable – a variable controlled by the research in which the effects can be neutralized by removing the variable.

vii. Intervening Variable – a variable which interferes with the independent and dependent variables, but its effects can either strengthen or weaken the independent and dependent variables.

A variable can be classified in a number of ways. However for purpose of this course we are looking at variables in three different ways: the causal relationship; the study design; the unit of measurement.

1.2.1 From the viewpoint of a causal relationship or association, four sets of variables may operate.

1. *change* variables, which are responsible for bringing about change in a phenomenon, situation or circumstance;
2. *outcome* variables, which are the effects, impacts or consequences of a change variable;
3. variables which *affect or influence* the link between cause-and-effect variables;
4. *connecting* or *linking* variables, which in certain situations are necessary to complete the relationship between cause-and-effect variables.

In research terminology, change variables are called independent variables, outcome/effect variables are called dependent variables, the unmeasured variables affecting the cause-and-effect relationship are called extraneous variables and the variables that link a cause-and-effect relationship are called intervening variables. Hence:

1. Independent variable - the cause supposed to be responsible for bringing about change(s) in a phenomenon or situation.

2. Dependent variable - the outcome or change(s) brought about by introduction of an independent variable.

3. Extraneous variable - several other factors operating in a real-life situation may affect changes in the dependent variable. These factors, not measured in the study, may increase or decrease the magnitude or strength of the relationship between independent and dependent variables.

4. Intervening variable - sometimes called the confounding variable (Grinnell 1988: 203), it links the independent and dependent variables. In certain situations the relationship between an independent and a dependent variable cannot be established without the intervention of another variable. The cause, or independent, variable will have the assumed effect only in the presence of an intervening variable.

To explain these variables let us consider some examples. Suppose you want to study the relationship between smoking and cancer. You assume that smoking is a cause of cancer. Studies have shown that there are many factors affecting this relationship, such as the number of cigarettes or the amount of tobacco smoked every day; the duration of smoking; the age of the smoker; dietary habits; and the amount of exercise undertaken by the individual. All of these factors may affect the extent to which smoking might cause cancer. These variables may either increase or decrease the magnitude of the relationship.

In the above example the extent of smoking is the independent variable, cancer is the dependent variable and all the variables that might affect this relationship, either positively or negatively, are extraneous variables.
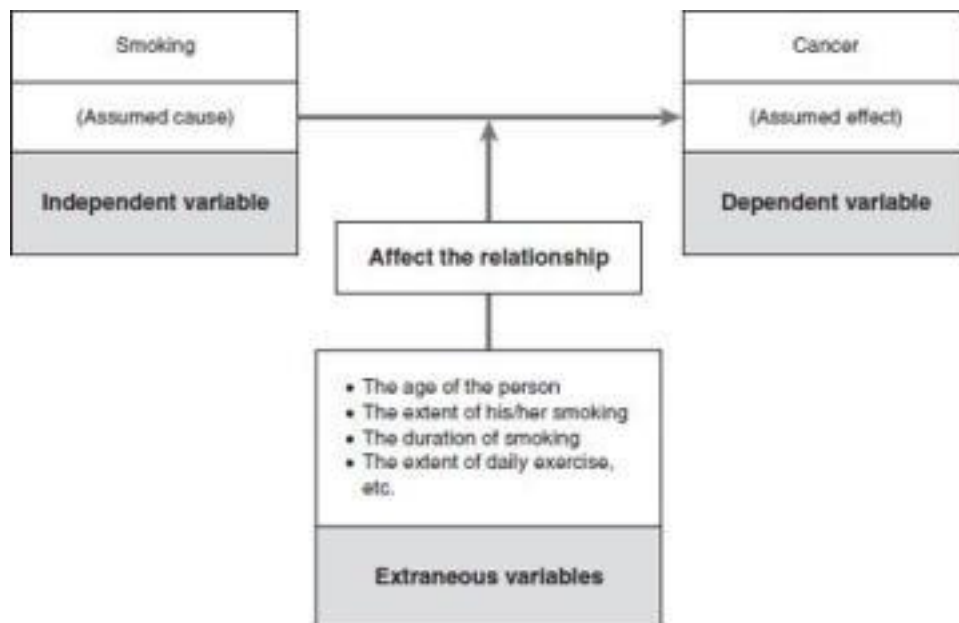
Figure 1. Independent, Dependent and Extraneous Variables

1.2.2 From the viewpoint of the study design

A study that examines association or causation may be a controlled/contrived experiment, a quasi experiment or an ex post facto or non-experimental study. In controlled experiments the independent (cause) variable may be introduced or manipulated either by the researcher or by someone else who is providing the service. In these situations there are two sets of variables

Active variables - those variables that can be manipulated, changed or controlled.
Attribute variables - those variables that cannot be manipulated, changed or controlled, and that reflect the characteristics of the study population, for example age, gender, education and income.

Suppose a study is designed to measure the relative effectiveness of three teaching models (Model A, Model B and Model C). The structure and contents of these models could vary and any model might be tested on any population group. The contents, structure and testability of a model on a population group may also vary from researcher to researcher. On the other hand,

a researcher does not have any control over characteristics of the student population such as their age, gender or motivation to study. These characteristics of the study population are called attribute variables. However, a researcher does have the ability to control and/or change the teaching models. S/he can decide what constitutes a teaching model and on which group of the student population it should be tested (if randomisation is not used).

1.2.3 From the viewpoint of the unit of measurement

From the viewpoint of the unit of measurement, there are two ways of categorising variables:

1. Whether the unit of measurement is categorical (as in nominal and ordinal scales) or continuous in nature (as in interval and ratio scales);
2. Whether it is qualitative (as in nominal and ordinal scales) or quantitative in nature (as in interval and ratio scales).

On the whole there is very little difference between categorical and qualitative, and between continuous and quantitative, variables. The slight difference between them is explained below.

Categorical variables are measured on nominal or ordinal measurement scales, whereas for continuous variables the measurements are made on either an interval or a ratio scale. There are three types of categorical variables: constant variable - has only one category or value, for example taxi, tree and water; dichotomous variable - has only two categories, as in male/female, yes/no, good/bad, head/tail, up/down and rich/poor; polytomous variable - can be divided into more than two categories, for example religion (Christian, Muslim, African Traditional Religion); political parties (Labour Party, All Progressive Congress, People Democratic Party); and attitudes (strongly favourable, favourable, uncertain, unfavourable, strongly unfavourable).

Continuous variables, on the other hand, have continuity in their measurement, for example age, income and attitude score. They can take any value on the scale on which they are measured. Age can be measured in years, months and days. Similarly, income can be measured in naira and kobo.

In many ways qualitative variables are similar to categorical variables as both use either nominal or ordinal measurement scales. However, there are some differences. For example, it is possible to develop categories on the basis of measurements made on a continuous scale, such as measuring the income of a population in naira and kobo, or dollars and cents and then developing categories such as 'low', 'middle' and 'high' income. The measurement of income in naira and kobo or dollars and cents is classified as the measurement of a continuous variable, whereas it's subjective measurement in categories such as 'low', 'middle' and 'high' groups is a qualitative variable.

Although this distinction exists, for most practical purposes there is no real difference between categorical and qualitative variables or between continuous and quantitative variables.

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